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USER'S GUIDE TO MOAOPS AND BOOM-MAP COMPUTER PROGRAMS FOR SONIC BOOM RESEARCH

Volume 1

Emma Wilby
Richard Horonjeff
Dwight Bishop

BBN Laboratories, Incorporated
21120 Vanowen Street
Canoga Park, California 91303

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Air Combat Maneuvering Instrumentation/Tactical Air Combat Training Systems (ACMI/TACTS) are used at several Military Operating Areas (MOA) in the United States and abroad as a post-flight pilot debriefing aid in training for air-to-air combat. Engineering flight data, including spatial position versus time information, are acquired and recorded from several radar facilities simultaneously during flights in appropriately instrumented MOAs. These data are used to generate the information required for subsequent graphical replays of the aircraft position, airspeed, g-value, attitude, climb/dive angle, etc. of the training sortie at post-flight debriefings.

This report describes the MOAOPS and BOOM-MAP computer programs developed under this contractual effort. Whenever the airspeed is greater than 0.99 Mach, MOAOPS extracts the engineering data from digital magnetic ACMI/TACTS tapes and formats the data into files which can be operated on directly by BOOM-MAP. BOOM-MAP: (1) generates various

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spatial/temporal distribution statistics; (2) interfaces with sonic boom generation and propagation models; (3) calculates the intensity and location of sonic booms reaching the ground; and (4) provides the data file used by a commercial graphical software package (CALCOMP) to plot contours of boom exposure in units of average peak overpressure or C-weighted day-night average sound level (CDNL).

These two programs, when used with an adequate library of aircraft sorties from Military Operating Areas, can be an invaluable tool for environmental planning purposes to predict boom intensity, frequency and distribution.

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawing, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical information Service, where it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

GERAL L. LONG, Major, USAF
NSBIT Program Manager

FOR THE COMMANDER

MICHAEL G. MACNAUGHTON, Col, USAF BSC
Director of Systems Acquisition
Research, Development & Acquisition
Aerospace Medical Division

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USER'S GUIDE TO MOAOPS AND BOOM-MAP COMPUTER PROGRAMS FOR SONIC BOOM RESEARCH

1.0 INTRODUCTION

This report presents a user's guide to two computer programs for analyzing noise from supersonic aircraft operations in military operating areas (MOA's). The two programs are designed to extract and analyze information from the Tactical Air Crew Combat Training System/Air Combat Manuevering Instrumentation (TACTS/ACMI) manufactured by the Cubic Corporation. The TACTS/ACMI system digitizes various positional and performance parameters of the aircraft on the range at frequent intervals for later replay in graphic or tabular form during air crew briefings.

The MOAOPS program extracts information from a TACTS/ACMI mission standard data tape and compiles a library of information concerning the supersonic operations. The BOOM-MAP program utilizes the library produced by the MOAOPS program. BOOM-MAP calculates various statistics on the super-sonic operations. It also calculates expected sonic-boom levels on the ground based on the extracted information. Both programs are written in Fortran 77 and operate in batch mode on Control Data Corporation (CDC) Cyber 170 Series machines.

The output of the BOOM-MAP program consists of: a) various statistical summaries; b) flight track information; c) calculated noise levels at a grid of ground positions (100 x 100 matrix). The output of the BOOM-MAP program is designed to be compatible with GPCP, a general purpose contouring program. Through the use of the GPCP program, the BOOM-MAP output can be displayed in terms of a) a map showing the flight track segments where the aircraft was supersonic; b) displays of the calculated sonic-boom "noise" in terms of several metrics.

Section 2 of the report is a user's guide to the MOAOPS program, while Section 3 is a user's guide for the BOOM-MAP program. Appendix A describes the computational equations and modeling algorithms predicting sonic boom characteristics on the ground. Appendix B contains information on the TACTS/ACMI mission standard data tape from the Data Reduction User Guide by Cubic Corporation. Appendix C presents examples of computer outputs from the MOAOPS and BOOM-MAP programs. Appendix D (which constitutes Volume 2 of this report) contains listings of both MOAOPS and BOOM-MAP programs.

2.0 MOAOPS PROGRAM

2.1 Overall Description

The MOAOPS program is in two parts, a data extraction program EXTRCT and an index deletion program DELETE. The Data Extraction Program reads a TACTS/ACMI Mission Standard Data tape, extracts relevant information and appends this information to either a new or existing data base.

The TACTS/ACMI Mission Tapes contain data on up to 8 instrumented aircraft flying a mission on the range. Among the data is real time information on aircraft position, velocity and acceleration, updated at intervals of 100 to 200 milliseconds. The program extracts this data for the sonic boom analysis from these tapes at approximately 1.5 second intervals in order to minimize both the time taken to read the tapes and the quantity of information to be stored.

The information is then appended to either a new or an existing library file, which accumulates the information from all the mission tapes analyzed. This library file is indexed, so that a particular mission, aircraft type, etc., can be accessed by the sonic boom analysis program.

Two index files are formed, the first containing only the mission names, dates and site location for all the tapes analyzed. In addition, the second index contains information on every aircraft flying for every mission analyzed, such as aircraft type, aircraft tail number, starting and ending time of the mission. Each entry in this index file is associated with a time series of data stored in the library file, and the appropriate record numbers for the library file access are stored in the index file. This index file is then used by the sonic boom analysis program, both for selection of the flights to be analyzed and information on access to the time series data to be read from the library file.

During a mission, it is possible that changes may occur in the aircraft flying, or that erroneous data has been included in the mission tape and later corrected. The program detects any change in the number of aircraft flying, aircraft type or aircraft tail numbers and signifies the start of a new mission segment when this occurs. The index file contains one entry for each aircraft flying in each mission segment. The library file has an associated time series of data for each aircraft flying each mission segment.

Two choices are available for the data extraction program.

1. Only supersonic data (M>0.99) may be stored in the library file or all data (subsonic and supersonic) may be stored. It is important to keep the index and library files for these two cases distinctly separate, as the sonic boom analysis program uses only the supersonic data.

2. The sonic boom analysis program only requires data at time intervals of approximately 1.5 seconds for reasonable accuracy. However, an option in the data extraction program is available to read and store data in the library file at 100 or 200 millisecond intervals. The intention is to make it possible to analyze a few flight tracks in great detail if necessary. This option is not recommended for building a data base of many missions as the quantity of data could become prohibitively large and should not be used for the BOOM-MAP data base.

In addition to the data extraction program, a program to delete entries from the index files has been written. The program does not delete any information from the library file, but deletes the index entry and all references giving access to the library information associated with the index entry. The index deletion feature is necessary in case mission tapes have been analyzed that should not form part of the permanent data base, or some index entries show errors that occurred on the TACTS/ACMI tapes.

2.2 TACTS/ACMI Tape Format

The tapes are written in a binary format on a 9-track tape at a density of 1600 bytes per inch (IBM compatible). The tape records consist of 32 bit words, with varying numbers of words in each record. Since the tapes are being analyzed using CDC computers, the data extraction program must translate the 32 bit binary format to standard CDC 60-bit alphanumeric data before any data can be read.

Four types of records may appear on the tape.

1. Tape Label (Header) Record, specifying mission name, date and site, and tape reel number.

2. Static Data Record, giving details of the exercise being flown. This includes the starting time of the mission segment and, for up to 8 high activity aircraft flying, each aircraft type and aircraft tail number. The data appears in the Exercise Data Message Blocks 201, 202, or 203.

3. Dynamic Data Record.

   For every aircraft flying, the record contains information at 100 or 200 millisecond intervals on the range positions of the aircraft, Mach number, velocities (for all 3 axes), and normal acceleration. The data appears in the Filter Output Blocks 305.

The time interval at which the data is available depends on the number of aircraft flying.

1 - 4 aircraft, 100 millisend intervals
5 - 8 aircraft, 200 millisecond intervals

There is also an indicator (U-bit) which is associated with probable errors in the data. When this indicates unreliable information, the Block 305 being read is ignored by the data extraction program.

The range positions of the aircraft have a default position given by

$$x = -280,000 \text{ feet}$$
$$y = +280,000 \text{ feet}$$

When this occurs, the Block 305 being read is ignored by the program, as no data are being transmitted. In addition, all positions outside the area $x = \pm 200,000$ ft, $y = \pm 200,000$ ft are ignored.

4. Watchdog Data Record

This is transmitted when any change of data in the Static Data Record occurs or at the end of a mission tape. Only the ending times of the mission segment is read from this record.

A detailed description of the record formats is given in Appendix B which is taken from Ref [1].

2.3 TACTS/ACMI Tape Layout

The tapes begin with a tape label record followed by a static data record and repeating dynamic data records which continue until one of the following conditions occur.

1. Watchdog Data Record

   End of file mark.

   This signifies an end of mission.

2. Watchdog Data Record

   New Static Data Record.

   Repeating Dynamic Data Records.

   This signifies a change in exercise data.

3. End of Tape Mark

   This signifies the end of a reel, not the end of the mission. A multiple reel request should appear in the program control statements.

The last record on the mission tape (or last reel of the tapes) is a Watchdog Data Record.

Appendix B shows the layout of a Mission Standard Tape.

2.4 Program EXTRCT Description

The input data are read in, specifying the options for:

a. storing supersonic data or both supersonic and subsonic data,
b. creating a new database or appending the data to an existing database,
c. printing the index only for the current mission tape being analyzed or the whole index,
d. specifying if the first tape to be analyzed must be Reel No. 1 or not.

Files required for both permanent and temporary storage are opened.

1. Mission Index File "MINDEX" - sequential.

2. Index File "INDEX" - direct access, record length 98.
3. Database File "LIBRY" - direct access, record length 70.
4. Eight temporary files, "TAPE11" through "TAPE18" - direct access, record length 70.

It is suggested that the files "INDEX" and "LIBRY" should be defined as Direct Access Files for permanent file storage since they may eventually become large. The files are described in detail in Section 2.5.

The program then reads each record in turn from the mission tape and checks the record type.

2.4.1 Tape Label (Header) Record

The mission name, date, site, and tape reel number are read from this record. Typically, there should only be one tape label record on each tape reel, starting with Reel 1. In practice, there may be more than one label record on a tape, and the tape available for analysis may not necessarily be Reel 1. The program checks that:

a. Reel 1 is read first, if specified by the input data. The program will stop if other reel numbers are read first and must be re-run either using the correct tape or modifying the input data to permit other than Reel 1 to be used.

b. Any subsequent label records should either have the same reel number or be incremented by 1 for multiple reels. If not, the program will stop and must be re-run using the reels in the correct sequence.

The mission name is modified by the program if necessary to remove leading blanks and to replace embedded blanks with hyphens. This is necessary for the selection process in the BOOM-MAP portion of the program.

2.4.2 Static Data Record

The starting time of the mission segment, the number of aircraft flying, aircraft types, and tail numbers are read from this record for a maximum of eight aircraft. At the start of a mission segment these data are written to eight temporary files (one for each aircraft flying) together with the mission name, data, and site. Again, the aircraft tail number may be modified to remove leading blanks and replace embedded blanks with hyphens.

A new static data record appears every time there is a change in exercise data or a pod swap. The program compares the new static data with the previous data, and if there is no change or addition, continues to read the next record and accumulate dynamic data.

If there is a change in static data, the program ends the previous mission segment and writes the final records for the segment to the temporary files, giving the ending time and number of dynamic data records stored for that segment. The new static data are then written to the files for the start of the new mission segment.

Occasionally, at the start of a mission, information, such as aircraft type or tail number, may be omitted from the static data record. A second static data record may then be transmitted soon after correcting the error, and the program will treat this as a new mission segment. Similarly, the program may identify several mission segments when transmission is poor and records repeated or the tape restarted. The files created for these segments will probably contain little if any useful dynamic data and may be delected from the index file at a later stage (using the program DELETE).

If no aircraft identification can be read from a static data record, the mission segment is ignored and no dynamic data kept until the next static record is read.

2.4.3 Dynamic Data Record

The dynamic data records are output at typically 0.8-second intervals. The program checks the time at the start of a record and ignores the record if the time interval since the last record analyzed is less than 1 second. Thus, every second record is analyzed at approximately 1.5-second intervals.

The record contains information on every aircraft flying (time, Mach number, position, velocity, and normal acceleration) repeated in turn at 100- or 200-millisecond intervals. Only the first block of information on each of the eight aircraft is read, and if reliable, the data are written to the eight temporary files. If only supersonic data are required for the database, data are written to the files for $M > 0.99$ only. A count is maintained of the total records analyzed and of the supersonic records so that the percentage of time spent in supersonic flight can be calculated at the end of a mission segment for each aircraft.

If there is a parity error in the record, the whole dynamic data record is ignored and the next record is read. If the first block of data read for an aircraft is in the default position, the program will search the record for data on that aircraft until either reliable data are found or the end of the record is reached.

If the input specifies that all dynamic data be read (at 100 or 200 millisecond intervals), every dynamic record is analyzed and all valid blocks of information on the 8 aircraft are stored.

2.4.4 Watchdog Record

A watchdog record should appear either before a new static record or at the end of a mission tape, giving the ending time of either the mission segment or the whole mission. On occasion, the watchdog record does not appear and the ending time is taken either from the last dynamic record read or from the next static record. At the end of a mission segment the time, number of entries, and number of supersonic records are added to the temporary file for each aircraft.

2.4.5 End of File Mark

The end of the mission tape (or multiple reels) is indicated by an End of File mark. If this is missing, the program continues searching for the next record and will fail on reaching the end of the tape. It is not possible to analyze a mission tape that has been terminated incorrectly. Similarly, it is not possible to analyze only the first tape of multiple reels, as the final reel of the mission tape contains the End of File mark.

2.4.6 Updating of Library and Index Files

Only after a mission tape has been completely analyzed are the permanent files MINDEX, INDEX, AND LIBRY updated by the program. On completion of the job these files must be retained in mass storage or stored on tape as designated in the job control language.

The eight temporary files (containing the dynamic data) are appended to the library file for each aircraft in turn, and corresponding entries are added to both the index file and mission index file, with the date and time of the update.

2.5 Index and Library Files

Three permanent files are created and updated as each mission tape is analyzed.

2.5.1 Mission Index File 'MINDEX'

This is a formatted sequential file, containing mission names, dates and site only.

First record: Format (I5, A3, A10, A10)

- I5 NINDEX = Number of mission tapes analyzed
- A3 'SUP' indicates supersonic database or 'ALL' indicates (subsonic + supersonic) database
- A10 Date on which index was last modified
- A10 Time at which index was last modified

Second record onwards: Format (A16, A8, A10)
The file consists of (NINDEX) records, (maximum 1000) containing

- A16 Mission name
- A8 Date of mission
- A10 Site location

The exercise dates are in the form - Month/Day/Year.

2.5.2 Index File, 'INDEX'

This is a formatted, direct access file with record length = 98, containing information both on the aircraft flying and on access to the corresponding database records in the library file. There is one entry to the index file for each aircraft flying each mission segment.

First Record: Format (I6, A3, A10, A10)

I6 NINDX = Number of entries in INDEX file
A3 'SUP' or 'ALL' for supersonic or all database
A10 Date on which the index was last modified
A10 Time at which the index was last modified

Second Record onwards: Format (A16, A8, I2, A10, I8, I2, A6, A8, I10, I10, I10)

The file consists of (NINDX) records, each containing:

A16	Mission name
A8	Date of mission
I2	Site number
A10	Site location
I8	Starting time of mission segment
I8	Ending time of mission segment
I2	Aircraft type number
A6	Aircraft type
A8	Aircraft tail number
I10	Starting record number of the corresponding database in 'LIBRY' file
I10	Total number of records in the database in 'LIBRY' file (including 1st, 2nd, dynamic data and final records)
I10	Number of supersonic dynamic records in the database in 'LIBRY' file

The range times are in the form - Hour, Minute, Second, 1/100 Second

2.5.3 Library File 'LIBRY'

This is a formatted, direct access file with record length = 70, containing the dynamic database for each aircraft flying each mission segment.

First Record: Format (I10, A3, A10, A10)

I10 Total number of records in the file (including the first)
A3 'SUP' or 'ALL' for supersonic or all database
A10 Date on which the database was last modified
A10 Time at which the database was last modified

For each aircraft, for each mission segment

Starting record: Format (A16, A8, I8, A6, A8)

A16 Mission name
A8 Date of mission
I3 Starting time of mission segment
A6 Aircraft type
A8 Aircraft tail number

Second record: Format (I2, A10, I2, I2, I2, I2, A3)

I2 Site number
A10 Site location
I2 Aircraft type number
I2 Mission segment number
I2 Aircraft slot number
I2 Number of aircraft flying in this mission segment
A3 'SUP' or 'ALL' for supersonic or all database

Dynamic Data Records: Format (2X, I8, F6.3, 3F8.0, F6.1, 3F6.0, F6.3)

2X Two blank characters
I8 Range time
F6.3 Mach number
3F8.0 Range coordinates (x, y and z) in feet
F6.1 Dive/climb angle in degrees (climb + ve, Dive -ve)

3F6.0 Aircraft velocity (x, y and z) in feet/sec.

F6.3 Aircraft normal acceleration in g.

Final Record: Format (I8, I8, I8)

I8 Ending time of mission segment

I8 Number of records stored for this aircraft and mission (segment includes 1st, 2nd and final records)

I8 Number of supersonic records stored.

2.5.4 Permanent File Storage

The files 'LIBRY' and 'INDEX' may become large and it is recommended that the files be DEFINED as Direct Access Files on the mass storage system, and attached using

```
ATTACH, INDEX = ****/M = W,NA.
ATTACH, LIBRY = ****/M = W,NA.
```

where **** are the users permanent file names. This prevents possible errors if more than 1 tape is being analyzed simultaneously. The sequential file 'MINDEX' should be REPLACED at the end of the tape analysis. It is suggested that, from time to time, the 3 files 'LIBRY', 'INDEX' and 'MINDEX' be copied to magnetic tape for back-up.

2.6 Program EXTRCT Input Data

Only 5 lines are required for input, each in character form, contained in apostrophes.

(1) 'SUPERSONIC DATA ONLY' or 'ALL DATA SELECTED'. The first option selects dynamic records for Mach numbers M>0.99. The second option selects subsonic and supersonic data, with no restriction on Mach number.

(2) 'DATA AT >1 SECOND INTERVALS' or 'ALL DYNAMIC DATA'. The first option reads dynamic data records at approximately 1.5 second intervals. The second option reads all the dynamic data output at 100 or 200 millisecond intervals, but should not be used in forming the supersonic database for BOOM-MAP.

(3) 'NEW INDEX AND LIBRARY FILES TO BE CREATED' or 'OLD INDEX AND LIBRARY FILES TO BE USED'. The first option is used only for the first mission tape analyzed in starting the library and index files. The second option is used for the second mission tape analyzed and thereafter.

(4) 'FULL INDEX PRINTED' or 'UPDATED INDEX ONLY'. As many tapes are analyzed, the index file may get quite large. The 'FULL' index prints the whole file, while 'UPDATED' prints only the mission currently being analyzed.

(5) 'ONE = NUMBER OF FIRST TAPE REEL READ' or 'ANY = NUMBER OF FIRST TAPE REEL READ'. If the option 'ONE' is used, the program will stop unless tape reel number 1 is mounted. The option 'ANY', permits any reel number to be the first tape reel, but multiple tape reels must still follow in sequence.

2.7 Program EXTRCT Output Data

Examples of the output from program EXTRCT are given in Appendix C.

The first table contains information only on the mission tape being analyzed and includes any warning messages that may occur during the analysis. These include parity errors, unidentified block types, etc., which may be useful to determine if the data in a mission segment is suspect. This table should be scrutinized to determine whether any mission segments should be deleted from the index at a later date. The possible reasons for deletions are:

a. Obvious errors in aircraft data, such as omission of A/C type.

b. Many parity errors, indicating a poor quality tape and insufficient data.

c. False start of a mission (due to data omission or poor tape) giving a very short initial mission segment, which could be ignored.

d. No supersonic activity.

The second table is a direct echo of the information stored on the library file and has been deliberately left in the same format.

The third table is a listing of the index file, either the FULL index or the UPDATED index only (the mission currently being analyzed), as specified by the input.

The fourth table is a listing of the mission tapes analyzed for the database.

2.8 Program DELETE Description

The program DELETE provides two modes of operation - the delete mode and the change mode. In the delete mode the program is run as a batch job to delete data on a specific mission or aircraft. The delete mode input data are described in Section 2.9. In the change mode the program is used interactively to change mission names in both the 'INDEX' and 'LIBRY' files.

In order to delete data on a specific mission or aircraft from the database 'LIBRY', created using program EXTRCT, it is only necessary to delete all references to that specific data from the index files 'INDEX' and 'MINDEX.' The program DELETE (in the delete mode) reads the existing files 'INDEX' and 'MINDEX', modifies them as selected by the input the outputs new files 'INDEXN' and 'MINDEXN' in the same format with the appropriate index entries deleted.

The file 'INDEXN' should again be defined as a Direct Access File for permanent storage if the file 'INDEX' was previously so defined. The users permanent file names used for storing the existing files 'INDEX' and 'MINDEX' and the new modified 'INDEXN' and 'MINDEXN' files should differ. On completion of the program, the output will list the index entries deleted and this output should be checked before purging the 'INDEX' file and thus permanently preventing access to the deleted entries. Typically the deletions will not be necessary until the database is to be accessed by the BOOM-MAP program, and a copy of the full, unmodified index should be kept on the back-up magnetic tape.

In the change mode, program DELETE copies the 'MINDEX', 'INDEX', and 'LIBRY' files onto new files 'MINDEXN', 'INDEXN', and 'LIBRYN'. The original files are closed and all changes are made in the new files. In file 'MINDEXN', only the date and time in the first record are changed. These new files should be defined for permanent storage in the same manner as the original files, but with different user's permanent file names.

The program DELETE queries the operator for the 'INDEX' file entry number of the mission name to be changed. The original and the new mission names are printed for verification prior to the new mission name being written to the 'INDEXN' and 'LIBRYN' files. A log of the change model operations as well as a new listing of the 'INDEXN' file entries are written on file 'TAPE1'. File 'TAPE1' should be reviewed before deleting the old files.

2.9 Program DELETE Input Data

The data are input in character strings or integers, one entry per line. These data are used only in the delete mode.

'MISSION NAMES TO BE DELETED'		(Max No. 25)
'5203-15'	An example of a mission name.	
.	This must match exactly the entries in	
.	the mission index and library index	
.	files.	
.		
'ENTRY NUMBERS TO BE DELETED'		(Max No. 50)
1	Examples of entries to be deleted, one	
.	number per line.	
.		
.		
45	These refer to the INDEX file line	
.	numbers.	
.		
.		
39		
/EOF	End of file mark, signified end of entries.	

2.10 Program DELETE Output Data

Examples of the output from the delete mode of Program DELETE are given in Appendix C. The original index file is printed, the deleted entries are listed and the new index file 'INDEXN' and mission index file 'MINDEXN' are printed, with the data and time of the deletions.

3.0 BOOM-MAP, SUPERSONIC AIRCRAFT ACTIVITY SUMMARY AND BOOM STRENGTH PREDICTION PROGRAM

3.1 Overall Description

The BOOM-MAP data analysis computer program accesses the TACTS/ACMI database generated by the MOAOPS computer program discussed in Section 2.0. The data analysis program produces statistical and graphic output describing aircraft position parameters as well as various measures of predicted boom strength. This program utilizes the data available in the TACTS/ACMI flight data library to produce graphic and tabular descriptions of MOA range activity.

Tabular output are produced by the BOOM-MAP and are output directly to the line printer. To produce graphic output, BOOM-MAP creates a file compatible with California Computer Products' (CALCOMP) General Purpose Contouring Program (GPCP II). GPCP II* reads this file and generates the necessary plotter directives to produce hard copy graphic output.

Users control the database subset to be extracted from the library run through the use of an input data file. Through this file the user specifies:

1) the name(s) of the MOA ranges to be considered
2) mission names or dates
3) bounding times of day
4) aircraft types (specific tail numbers optional).

Users also specify desired output products. These include:

---

*A description of GPCP II is beyond the scope of this report. Interested readers are directed to Reference 2 for further information on the operation of this program.

1) A statistical summary of position, speed, and boom strength variables. This summary includes distribution functions of range x-coordinates and y-coordinates, and the aircraft z-coordinate (height above the range), all in feet. It also includes a distribution function of effective height (h_e). Distribution functions of Mach number, cutoff Mach number and effective Mach number are also presented. Estimated boom strength distribution functions include peak overpressure (in pounds per square foot), the peak overpressure (in dB, re: 20 microPascals), the C-weighted sound exposure level (in dB), and the A-weighted sound exposure level (in dB). The estimated boom strength are those calculated directly below the extended aircraft flight trajectory. Also included root mean square values for effective height, Mach number, effective Mach number, and cutoff Mach number.

2) A flight track map depicting ground projections of flight paths during supersonic activity.

3) A flight track map depicting ground projections of flight paths during sonic boom producing activity

4) A noise contour map of average C-weighted sound exposure levels (CSEL)

5) A noise contour map of C-weighted day/night average levels (CLDN), requiring input of the reference number of daytime operations which will be used to convert CSEL to CLDN.

6) A noise contour map of flight averaged peak over-pressures (in pounds per square foot).

Figure 1 presents a functional block diagram of the BOOM-MAP software package. The user supplied directives (described in detail in this section) are read first and stored in memory. Information on the library entries are then read one at a time from the library index file and the sortie parameters compared with the qualifiers provided by the user in the input directives. When a library sortie meets the screening criteria, its time history file is read from the library and the flight is processed by the BOOM-MAP program. A journal is concurrently output to the line printer (one line per sortie) which identifies the mission name, the date, the site location, the sortie starting and ending times, the aircraft type and tail number, the amount of supersonic time and the amount of boom producing time. This journal presents users with a complete listing of all qualifying sorties.

Processing of library data stops when all entries in the index file have been searched.

When the library index has been exhausted, the program prints the statistical summary tables (if requested) and then prepares an output file to the contouring and plotting program, GPCP II. The BOOM-MAP program then terminates. When GPCP II is called, the file prepared by BOOM-MAP provides a complete input directive list to GPCP. GPCP then produces flight track and contour maps as requested by the user.

The files required for input or output by the BOOM-MAP program are:

1) Index file "INDEX" - direct access, record length 98
2) Database file "LIBRY" - direct access, record length 70
3) Two temporary files TAPE3 and TAPE4 - sequential
4) Output file for input to GPCP II program, TAPE11 - sequential

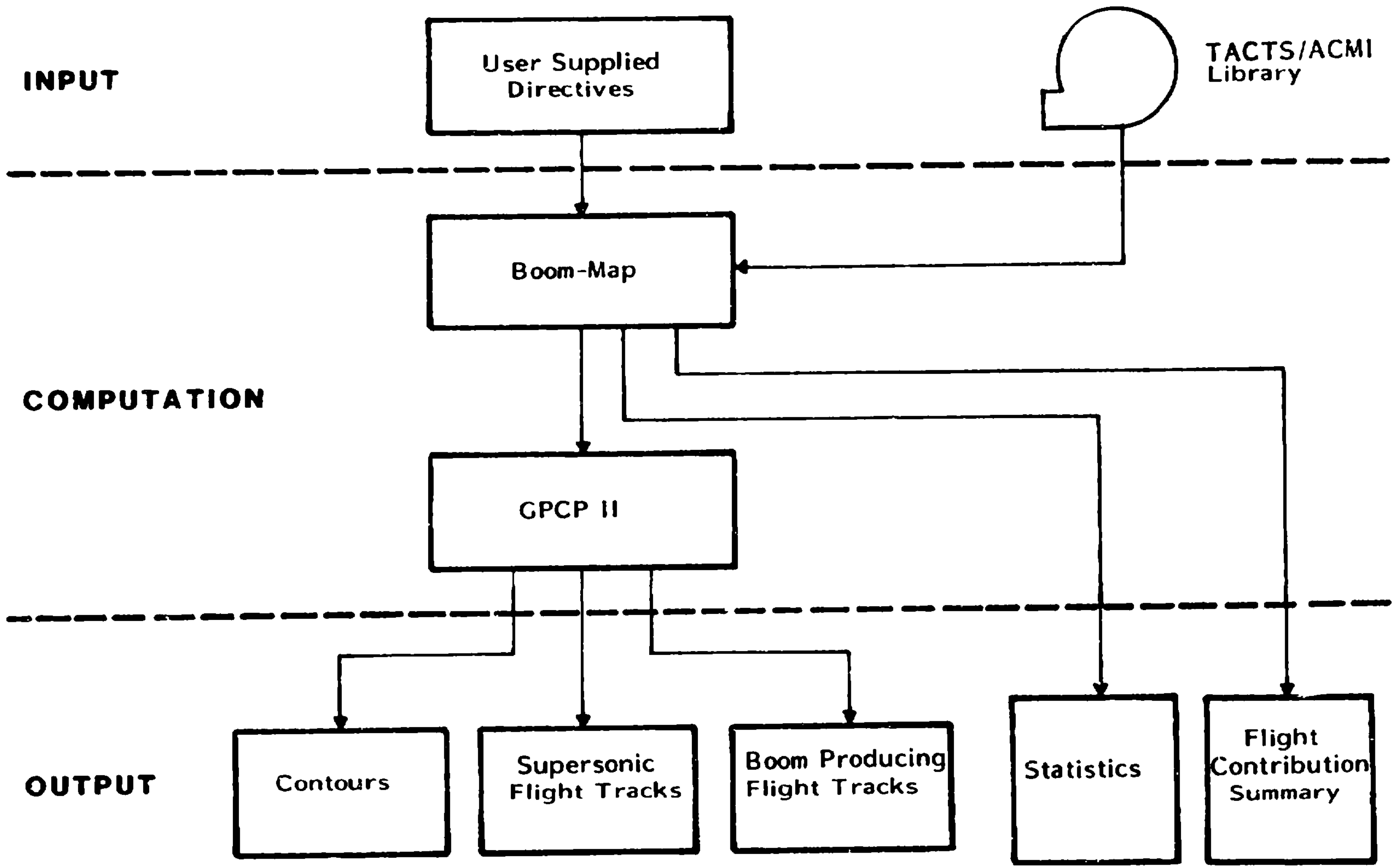


FIGURE 1. FUNCTIONAL RELATIONSHIP BETWEEN ELEMENTS OF BOOM-MAP COMPUTER PROGRAM

3.2 User's Guide

This section presents a user's guide for operating the BOOM-MAP program. The guide describes the file of input cards necessary to control a BOOM-MAP run.

The complete run specification consists of three groups of information. These groups are:

1) a title card which is printed on all output products

2) qualifiers used to control the particular flights extracted from the library.

3) specifiers used to control the particular output products required by the user.

All input file data cards are free format; that is, data is not restricted to particular card columns. Instead, a key word at the beginning of the card specifies the type of data to follow, and parameter values are simply separated by commas in most cases. Spaces between parameters are ignored and if the parameter list exceeds the 80 column allowable card width, the user may continue on the next card without the need for any special continuation characters.

3.2.1 TITLE Card

This card must be the first card in the input file. The key word "TITLE" followed by a space tells the program to accept up to 70 characters for a title. This title will be printed on all output products. The format is

TITLE title of run

3.2.2 Library data qualifier cards

Access to the information stored in the database library is through the use of qualifier cards. These qualifier cards allow the user to specify criteria for records that are to be included for analysis. The input file may contain from one to five "packets" of qualifiers, where a packet consists of four of the six available qualifier input cards. The input cards are "SITE" "MISSION', "DATE', "TIME', "AIRCRAFT" and "ACWTN'. "ACWTN" is the qualifier to call for aircraft with tail numbers. The input cards must correspond with the following sequence:

"SITE"
"MISSION" or "DATE"
"TIME"
"AIRCRAFT" or "ACWTN"

Each input card is followed by one or more parameters separated by a comma or by the word "ALL." The maximum umber of parameters allowed is based on the input card. Note that when specific parameters (eg. missions, aircraft, etc.) are specified they must match exactly the way they are stored in the library index, character for character. In addition, if a sortie qualifies in more than one way with the user input directives, it will still be included only once in the analysis.

CARD I: (SITE)

The SITE card allows the specification of 1 or more MOA site location names in the input file. The user is allowed a maximum of 20 site location names separated by commas. Site names can occur on more than one line if necessary.

Example: SITE Loc 1, Loc 2, Loc 3,...Loc 20

SITE Loc 1, Loc 2,
Loc 3,...Loc 20

The parameter "ALL" is used when all site locations are to be included.

Example: SITE ALL

CARD II: (MISSION or DATE)

The input card "MISSION" allows the specification of one to ten mission names separated by commas. Mission names may occur on more than one line if necessary.

Example: MISSION Name 1, Name 2,...Name 10

-or-

MISSION Name 1,
Name 2,...Name 10

The parameter "ALL" is used when all Missions are to be included. When the user specifies the "MISSION" card instead of the "DATE" card for input Card II, all dates are considered legal. Once "MISSION" is specified in a packet "DATE" is no longer legal.

The input card "DATE" allows for the specification of one to ten date intervals separated by a comma. Date intervals may occur on more than one line. A date interval consists of a start date followed by a hyphen followed by an end date or simply a start date. All dates must appear as MM/DD/YY format. If only a start date is given, then the end date will be considered identical to the start date.

Example: DATE 01/21/85-02/1/85, 4/8/85,
7/18/86-7/19/86

The parameter "ALL" may be used when all dates are to be included. When the user specifies the "DATE" card instead of the "MISSION" card as input card II, "MISSION" is no longer legal within that packet.

CARD III (TIME)

The input card "TIME" allows for the specification of one to ten time intervals separated by commas. Time intervals may occur on more than one line. A time interval consists of a start time followed by a hyphen followed by an end time or simply a start time. All times must appear as HHMM format. If only a start time is given, then the end time will default to 2359.

Example TIME: 1100-1200, 1300-1330
1400-1500, 1700

The parameter "ALL" is used when all time intervals are to be included.

CARD IV: AIRCRAFT OR ACWTN

Aircraft may be specified in two ways; either by aircraft type alone, or by a specific aircraft type and tail number.

The input card "AIRCRAFT" allows the specification of one or more aircraft types in the input file. The user is allowed a maximum of ten aircraft types separated by commas. Aircraft types may occur on more than one line. Once "AIRCRAFT" has been specified, "ACWTN" is no longer legal within that packet. The parameter "ALL" may be used when all aircraft types are to be included.

Example AIRCRAFT Type 1, Type 2, Type 3,
Type 4...

Example AIRCRAFT ALL

The input card "ACWTN" allows the specification of one or more aircraft types followed by their corresponding tail numbers. The user is allowed a maximum of ten aircraft/tail number pairs separated by commas. Aircraft/tail number pairs may continue on more than one line.

Example: ACWTN AC1 TN1, AC2 TN2,
AC3 TN3

The parameter "ALL" may be used when all aircraft types and tail numbers are considered legal. Once "ACWTN" has been used, "AIRCRAFT" is no longer considered legal. If the user specified "AIRCRAFT" as input card IV, then all tail numbers are considered to be legal.

3.2.3 Output Product Specification Cards

The type of output data desired by the user is specified by one or more output specification cards. These cards may be entered in any order.

"STAT" Card

This card tells the program to print a full statistics summary. An example of this summary is shown in Figure 2 and includes distribution functions of x, y, and z position variables, effective height, Mach number, and estimated boom strength (directly below the aircraft). Also included are RMS values of effective height, Mach number, cutoff Mach number, and effective Mach number.

"MACHTRK" Card

```
TITLE: LUKE AFB MOA - - - LIBRARY AS OF 23 JAN 1986

X-COORD                      LOWER BOUND CELL 2 = -132000.0    CELL SIZE = 5280.000
   0    0    0    0    0    0    0    0    0    7    7    7    0   21   16   24   30    2    0    0
   0    2    5    3    2    3    4    4    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0

Y-COORD                      LOWER BOUND CELL 2 = -132000.0    CELL SIZE = 5280.000
   0    0    0    0    0    0    0    0    0    2    4    1    0    0    0    2    6    4    5    7
   1    0    0    0    0    2    4   10    7    8    6    6   12   10    7    5    3    4    4    4
   4    5    4    0    0    0    0    0    0    0    0    0

Z-COORD                      LOWER BOUND CELL 2 =      750.0    CELL SIZE = 1000.000
   0    0    0    0    0    6   12    0    3    2    3   13   10    9    7    4   11    8    6    6
  10   13    5    4    0    1    0    0    0    3    3    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0

EFFECTIVE HEIGHT             LOWER BOUND CELL 2 =         .0    CELL SIZE = 1000.000    RMS =12840.672
   0    0    0    0    8   14    4    0    5    4    6   18   22   20    0    2    1    3    8    9
   4    1    4    2    0    2    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0

MACH NUMBER                  LOWER BOUND CELL 2 =        1.0    CELL SIZE =      .020    RMS =     1.136
   0    0   18    3    9   36   17   12    8    6    5    2    2    0    3    6   10    2    0    0
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

CUTOFF MACH NO.              LOWER BOUND CELL 2 =        1.0    CELL SIZE =      .020    RMS =     1.065
   0    0   23   41   34   34    1    6    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

EFFECTIVE MACH NO.           LOWER BOUND CELL 2 =        1.0    CELL SIZE =      .020    RMS =     1.254
   0    0   12    5    3    5   11   13   11    1    4    3    9    7    6    1    4    7    1    1
   4    2    1    5    4   12    1    2    2    2    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

OVERPRESSURE (PSF)           LOWER BOUND CELL 2 =         .0    CELL SIZE =      .250
   0    0    0    0    0    5    3    2   14   13    9   12    4    7   11    9    6   19    0    0
   0    0    0    0    0    0    0    0    0    0    0    1    1    2    6    3    1    3    2    2
   0    2    1    1    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0

PEAK LEVEL                   LOWER BOUND CELL 2 =      115.0    CELL SIZE =      .500
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    0    0    5    1    0    2    0    1    1    4    9   10    3
   5    4    7    8    1    3   10    6    6    4   16    3    0    0    0    0    0    0    0    0
   0    1    4    8    4    4    3    2    0    0    0    0    0    0    0    0    0    0    0

C-LEVEL                      LOWER BOUND CELL 2 =       90.0    CELL SIZE =      .500
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    0    0    0    5    1    0    2    0    1    1    4    9   10    3    5    4
   7    8    1    3   10    6    6    4   18    3    0    0    0    0    0    0    0    0    0    1
   4    8    4    4    3    2    0    0    0    0    0    0    0    0    0    0    0    0    0

A-LEVEL                      LOWER BOUND CELL 2 =       60.0    CELL SIZE =      .500
   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   0    0    0    0    5    1    0    0    0    2    0    0    1    1    4    2    7   10    2    2
   4    3    4    4    7    2    1    2    6    7    3    7    4    7   15    0    0    0    0    0
   0    0    0    0    0    0    0    0    1    2    5    5    4    3    3    1    2    0    0

TIME GREATER THAN MACH 1.0 (SEC) =   345     TIME GREATER THAN CUTOFF MACH NO (SEC) =   139
```

FIGURE 2. SAMPLE STATISTICAL OUTPUT

This card directs the program to generate a flight track map showing those portions of sortie flight tracks where the aircraft Mach number exceeded 1.0. This card contains one numeric parameter which specifies the map scale ratio. For example, to produce a map of one inch equals 10,000 feet the scale ratio is 120,000.

The smallest scale factor possible is 1:2600 feet dictated by the numerical input limitations to GPCP. The largest realistic scale factor is 1:45,000 feet, giving a plot approximately 5"x5" in size.

Example: MACHTRK 120000

"BOOMTRK" Card

This card directs the program to generate a flight track map showing those portions of sortie flight tracks where sonic booms were generated which propagated to the ground. This card contains a numeric parameter specifying the map scale ratio. For example, a map of one inch equals 10,000 feet is specified by a scale ratio of 120,000.

Example: BOOMTRK 120000

"CONTOUR" Cards

Contour cards are used to direct the program to produce maps depicting contours of equal boom strength. Three different types of contour maps may be specified: (1) CSEL, (2) CLDN, and (3) peak overpressure, in psf. The CONTOUR cards contain a number of parameters which must be entered in a specific order.

CSEL contour maps are specified using the keyword CONTOUR followed by CSEL. Additional parameters must be separated by commas, and must be input in the following order. The first is the scale ratio of the contour map (see MACHTRK or BOOMTRK cards for a description of the scale ratio). Following the scale ratio at least one (up to a maximum of 20) CSEL contour values must be specified.

Example: CONTOUR CSEL, 120000, 95, 100, 105

Peak overpressure contour maps are specified using the keyword CONTOUR followed by PKOP. Additional parameters must be separated by commas, and are input in the same order as with CSEL contours. The first parameter is the scale ratio of the contour map. Following this parameter must be at least one (up to a maximum of 20) peak overpressure contour values in pounds per square foot. Fractional values are acceptable but the program rounds the user specified values to the nearest tenth of a psf for plotting purposes.

Example: CONTOUR PKOP, 120000, 0.5, 0.8, 1.0, 2.0

CLDN contour maps are specified using the keyword CONTOUR followed by CLDN. Additional parameters must be separated by commas and must be input in the following order. The first parameter is the map scale ratio. The second parameter is the reference number of daytime operations which will be used on a 10 log(N) basis to convert CSEL values to CLDN. Following these two parameters must be at least one (up to a maximum of 19) CLDN contour values to be plotted.

Example: CONTOUR CLDN, 120000, 44.5, 55, 60, 65, 70, 75

"WIDTH" Card

The WIDTH card contains a single parameter which tells the plotting software the paper width (in inches) of the plotting device used for the map output products. If the paper width is too narrow to accommodate the entire map, the plot software will automatically split the map into several panels which can then be assembled to form the full size map. This card may appear anywhere amongst the output product specification cards or immediately preceding them. The default width if this card is omitted is 36 inches.

Example: WIDTH 48

3.2.4 Input Example

The following are examples of input data. The first example is a simple case. The second example shows effective use of the data qualifier cards.

Example 1: Shown below is the input data deck for a relatively simple case:

```
TITLE     NELLIS MOA -- ALL ACTIVITY

SITE      NELLIS
MISSION   ALL
TIME      ALL
AIRCRAFT  ALL

STAT
MACHTRK  96000
```

In this example the title printed on all output is "NELLIS MOA -- ALL ACTIVITY".

The processing software will utilize data only from the NELLIS MOA site. It will, however, select all missions, times of day, and aircraft types. For output products the statistics package will be printed and a map showing flight tracks where aircraft exceeded Mach 1.0 will be plotted to a scale of 1 inch equals 8000 feet.

Example 2: In this example more explicit input qualifiers have been specified.

```
TITLE     HOLLOMAN MOA

SITE      HOLLOMAN
MISSION   5284711-14DA, 5282717-20GI
TIME      0700-2159
AIRCRAFT  F-15, F-4
SITE      HOLLOMAN
MISSION   5282723-26RO
TIME      0700-2159
AIRCRAFT  ALL
BOOMTRK   96000
CONTOUR   CSEL 96000, 95, 100, 105
CONTOUR   CLDN 96000, 25.2, 65, 70, 75
```

In this example the title "HOLLOMAN MOA" will be printed on all output products. In contrast to the first example the program will be fairly selective about the data it extracts from the library. Two packets of data qualifiers are included. Thus the program will select data from the library when either of the two packet conditions are met. It will select data when:

a) the site name is HOLLOMAN, and the mission numbers are 5284711-14DA or 5282717-20GI, and the mission starting time is between 0700 and 2159, and the aircraft type is an F-15 or F-4.

or when

t ı ..te name is HOLLOMAN, and the mission name is 2 723-26RO, and the mission starting time is between 07.. and 2159 for any aircraft sortie meeting these conditions.

The output products will include a flight track map of boom producing track segments to a scale of 1 inch equals 8000 feet. Two contour maps will be plotted. The first will be a CSEL contour map to a scale of 1 inch equals 8000 feet, containing the 65, 70, and 75 dB contours. The second will be a CLDN contour map also plotted to a scale of 1 inch equals 8000 feet. The reference number of daily operations is 25.2 sorties and the desired contours are 65, 70 and 75 dB.

3.3 BOOM-MAP Output

An example of BOOM-MAP output is shown in Appendix C. The first output page echoes the input specification cards provided by the user. It also summarizes in table form the library qualifier information which will be used to select specific flight data from the library for processing. The second page echoes the specific flights selected from the data base which qualify for processing based on the user supplied input specifications.

The third page contains distribution functions of distance, speed, and overpressure variables for times during which the aircraft Mach number is greater than cutoff. Each distribution function contains a number of histogram cells of specified cell size. The first and last cells are underrange and overrange cells used to collect the tails of the distribution which lie outside the expected range of the particular parameter. The remaining cells are of specific parameter range (identified as cell size in the printout).

For example, cell number N extends from:

Lower bound = [lower band cell 2] + (N-2) [cell size]
to Upper bound = [lower band cell 2] + (N-1) [cell size]

Each cell contains the number of occurrences of the parameter in the cell range at one second intervals. That is, the number contained in cell N is the number of seconds the parameter was observed in the cell parameter range.

The eleven parameters, defined in Appendix A, are:

1) range x-coordinate in feet (range: -132,000 to + 132,000 feet)

2) range y-coordinate in feet (range: -132,000 to +132,000 feet)

3) aircraft height above range center altitude in feet (range: 750 to 50750 feet)

4) aircraft effective height, h_e, above range center altitude in feet (range: 0 to 50000 feet)

5) aircraft Mach number (range: 1.00 to 2.14)

6) aircraft cutoff Mach number (range: 1.00 to 2.14)

7) aircraft effective Mach number (range: 1.00 to 2.14)

8) boom strength overpressure under the projected flight path in pounds per square foot (range: 0.00 to 14.25 psf)

9) boom strength overpressure under the projected flight

path in dB re: 20 microPascals (range: 115.0 to 153.5 dB)

10) C-weighted sound exposure level under the projected flight path in dB (range: 90.0 to 128.5 dB)

11) A-weighted sound exposure level under the projected flight path in dB (range: 80.0 to 118.5 dB)

The fourth and fifth pages are a combined two-dimensional distribution function of the x/y range coordinates, parameters 1) and 2) on the previous page. This distribution function shows the spatial distribution of aircraft position during boom producing activity. Cells 1 and 52 in both dimensions are the underrange and overrange tails of the distribution. In the x-direction cells 1 through 30 are shown in the first half of the table; cells 31 through 52 in the second half.

Examples of the flight track and contour maps output by GPCP II are also shown. Map annotation in the title block indicates the type of map plotted. Range coordinates are plotted on the left and top of the map, and a cross is plotted at the range center (coordinates x = 0, y = o). The y-axis points true north, and the latitude and longitude of the range center are given in the title block.

4.0 SOFTWARE MAINTENANCE

The TACTS/ACMI Mission Standard Tapes may eventually be available for 10 site locations. The programs contain site-specific information such as range center altitude, latitude, longitude and aircraft types which are not at present available for all the sites and may need to be added or modified at a later date. At present data has been included for the locations Nellis, Yuma, Oceana, Tyndall, Holloman and Luke. In addition, as new aircraft types are added, boom overpressure factors will be required.

The program calculates boom strengths at a fixed grid point spacing of 2500 feet, in the range $\pm$ 126,250 feet. Changing this calculation range is not a user's option, but it may occasionally be desirable to do so.

This section identifies the subroutines in the programs that would be affected by these modifications.

4.1 Maintenance of MOAOPS Program EXTRCT

The subroutines BLOCK DATA and SETUP form a data table, ACTYP, giving the aircraft types keyed to a site dependent number from 1 to 64 (see Appendix B). If any changes or additions of aircraft types are required, the table ACTYP must be modified.

4.2 Maintenance of BOOM-MAP Program

Any changes in the range center altitude, latitude and longitude will require modification of the subroutines RNGALT and RNGALL. Additions of new aircraft types and boom overpressure factors will require modification of the subroutine OPFIND.

Changes in the calculation range will affect the subroutine BLOCK DATA DICK. The number of grid points (102) should not be changed but the size may be changed by inserting new values for:

minimum range value, grid spacing, maximum range value

where maximum value = minimum value + 101 x grid spacing. The grid spacing in the x and y directions should be identical. The calculation range defines the maximum GPCP range that can be plotted and hence the smallest and largest scale factors possible for plotting will be altered.

REFERENCES

1. Data Reduction User Grade for Mission Standard Data Reduction Programs, Cubic Corporation, San Diego, California, Dec. 1981.

2. GPCP-II, A General Purpose Contouring Program, CALCOMP Applications Software, 1980.

APPENDIX A

CALCULATION OF SONIC BOOM OVERPRESSURES AND SOUND EXPOSURE LEVELS

APPENDIX A

CALCULATION OF SONIC BOOM OVERPRESSURES AND SOUND EXPOSURE LEVELS

1.0 BACKGROUND

This appendix describes the basic analytic expressions utilized in BOOM-MAP for calculation of sonic boom overpressure and the C-weighted sound exposure. The appendix also describes the computational algorithms used to implement the basic analytic expressions.

The BOOM-MAP program predicts sonic boom overpressures and/or the C-weighted sound exposure level on the ground based on a procedure developed by Carlson [A1] for predicting peak overpressures and durations of sonic booms produced by aircraft in steady-state flight. Intensive studies of sonic boom phenomena during the 1960's and 70's produced very accurate procedures for predicting the characteristics of sonic booms (A2, A3). Implementation of these prediction processes is performed with sophisticated computer programs that depend upon detailed knowledge of aircraft configurations and aerodynamic properties as well as the wave propagation characteristics of real and ideal atmospheres. Utilizing these models is a complex, lengthy, and expensive process. Carlson has been able to simplify the prediction process for peak overpressure and durations of sonic booms produced by aircraft in steady-state flight into an accurate procedure that does not require detailed aerodynamic and configuration information for individual aircraft. The procedure is generally quite applicable to any arbitrarily shaped flight vehicle with any reasonable flight trajectory.

In Reference A3, the Carlson procedure is provided as a series of equations involving a substantial number of coefficients that are obtained from graphical representations in his report. Limiting the use of the procedure to fighter airplanes, with Mach number and altitude ranges of interest for air combat maneuvering, allows the many graphical represention of parameters necessary for the computation to be expressed in analytical form. In Reference A4, Galloway developed analytic expressions from least-squares curve fits to Carlson's graphical data.

Carlson's equations plus the analytic expressions developed by Galloway form the basis for the prediction model employed in BOOM-MAP. Some additional assumptions, extensions and simplifications were required for modeling; these are also described in this appendix.

2.0 BASIC COMPUTATIONAL PROCEDURE

Before introducing the computational procedure, it is helpful to consider the geometrical relationships and terminology involved. Figure A-1 depicts schematically the parameters used in computations for sonic booms produced along the flight track directly beneath the airplane. The airplane is assumed to be in steady flight at altitude h_a above mean sea level (MSL), flight Mach number M, along a flight path with angle γ relative to a horizontal plane. Ground level is at height h_g above MSL, and thus the airplane is height h above ground, where $h = h_a - h_g$.

The effect of flight path angle γ is to introduce a parameter called effective height, h_e, which is used to compute peak overpressure on the ground. For airplanes in level flight h_e is equal to h. In a climb γ is positive, with h_e greater than h, and boom strength is less than that for level flight at the same Mach number. In a dive γ is negative, h_e is less than h, and boom strength is greater than that for level flight at the same Mach number.

Sonic boom wave fronts emitted when the airplane is at each point along its flight will propagate along a series of curved ray paths. Curvature is caused by the change in the speed of sound that results from the decrease in atmospheric temperature with increasing altitude (up to about 35,000 feet above MSL). Booms which propagate to the ground will strike the earth at a distance d_x along the flight path, measured from a point directly below the airplane.

Under certain combinations of Mach number and altitude, refraction in the atmosphere will cause the curvature of the ray path to tilt the sonic boom wave front sufficiently to become perpendicular to the ground, or even to turn the wave front

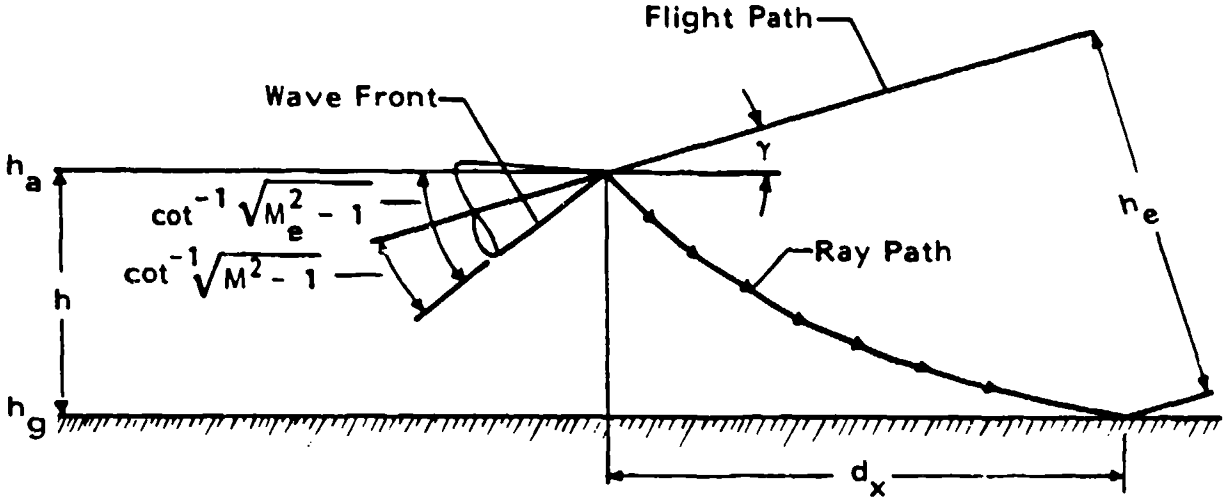


FIGURE A-1. SONIC BOOM GEOMETRY UNDERNEATH FLIGHT PATH

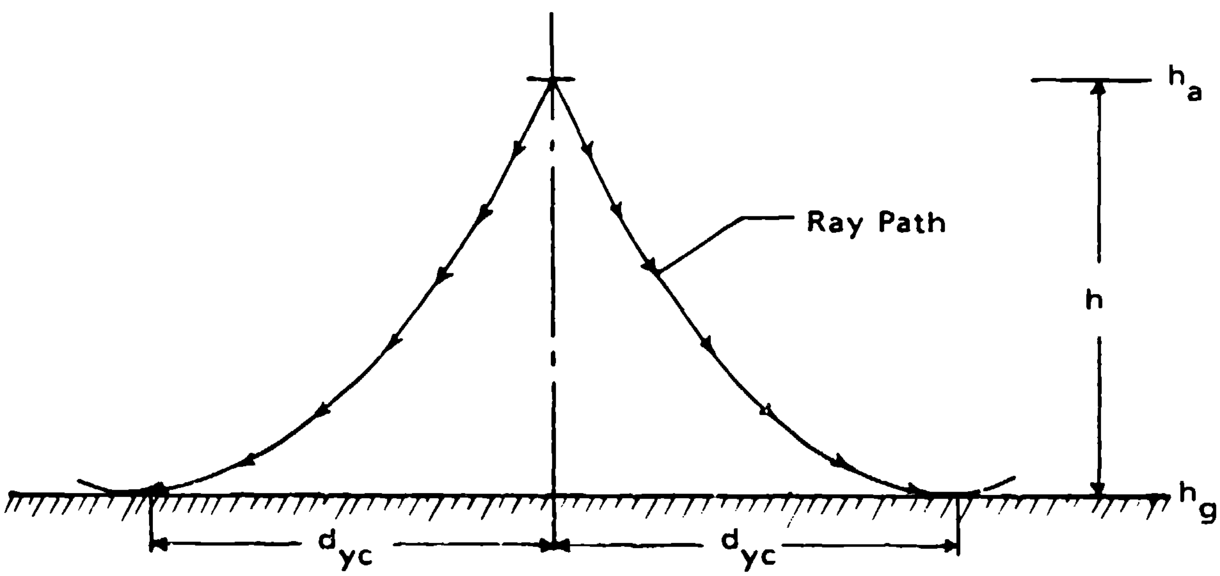


FIGURE A-2. SONIC BOOM GEOMETRY AT LATERAL CUT OFF before it reaches the ground. The Mach number for the condition where the ray path is tangent to the ground is called cutoff Mach number, M_c. At flight conditions below M_c, no boom reaches the ground.

The lateral extent of a sonic boom is limited by a similar refraction process, even for booms that reach the ground directly beneath the flight path, when M is greater than M_c. The distance to the side where the wavefront is perpendicular to the ground is called lateral cutoff distance, $d_{y,c}$, as shown in Figure A-2. Experimental data [A5] show that, in practice, sonic boom signatures tend to distort dramatically at distances of approximately 0.8 times $d_{y,c}$ and to essentially disappear at $d_{y,c}$.

With these points in mind, sonic boom parameters are predicted from the following equations:

2.1 Sonic Boom Overpressure and Duration

1. Effective Mach number, M_e:

$$M_e = \frac{1}{\sin\left(\gamma + \cot^{-1}\sqrt{M^2-1}\right)} \qquad (1)$$

2. Cutoff Mach number, M_c:

$$M_c = e^{4.033\times10^{-6}h_a} \qquad 0 \le h_a \le 35{,}300 \text{ ft} \qquad (2)$$

$$M_c = 1.153 \qquad 35{,}300 < h_a \le 65{,}600 \text{ ft}$$

3. Horizontal propagation distance, d_x, in feet:

$$d_x = K_d\left(\frac{h}{\sqrt{M_e^{\,2}-1}}\right) \qquad (3)$$

$$\text{where:}\quad K_d = K_{d,c} + \left(1.04 - K_{d,c}\right)\left(\frac{M_e - M_c}{M_e - 1}\right)^{n_d} \qquad (4)$$

$$K_{d,c} = 2 + (4.53\times10^{-6})h_a \qquad h_c \leq 35{,}300 \text{ ft} \qquad (5)$$

$$= 2.16 - (6.60\times10^{-6})h_a \qquad h_a > 35{,}300 \text{ ft}$$

$$n_d = 0.22 + (1.6\times10^{-6})h_a \qquad (6)$$

4. Lateral cutoff distance, $d_{y,c}$, in feet:

$$d_{y,c} = h\,\frac{(1 + M_c)}{M}\left(\frac{M^2 - M_c^{\,2}}{M_c^{\,2} - 1}\right)^{1/2} \qquad (7)$$

5. Effective height, h_e, in feet:

$$h_e = h\cos\gamma + d_x\sin\gamma \qquad (8)$$

6. Peak sonic boom overpressure, Δp, in pounds-per-square-feet:

$$\Delta p = \frac{8.4\times10^{3}\left(\delta_a\delta_\varepsilon\right)^{1/2}\left(M^2 - 1\right)^{1/8}}{h_e^{\,3/4}} \qquad (9)$$

where:

$$\delta_a = \left[1 - (6.8755\times10^{-6})h_a\right]^{5.2559} \qquad (10)$$

$$\delta_\varepsilon = \left[1 - (6.8756\times10^{-6})h_\varepsilon\right]^{5.2559} \qquad (11)$$

Note 1: At points lateral to the side of the flight path, distance d_y, such that $d_y \leq 0.8\ d_{y,c}$, the effective slant distance to the flight path, s_e, should be used in equation (9) instead of h_e. The effective slant distance is approximately:

$$s_e = (d_y^2 + h_e^2)^{1/2} \qquad (12)$$

Note 2: Equation (9) applies to F-14 and F-15 airplanes. To obtain Δp for other airplanes, or Δt from equation (13), apply the following multipliers:

F - 4	0.93
F - 5	0.76
F - 16	0.80
F - 18	0.91

7. Sonic boom duration, Δt, in seconds:

$$\Delta t = 5.8\text{x}10^{-3} \left[\frac{M}{(M^2 - 1)^{3/8}}\right] h_e^{1/4} \qquad (13)$$

2.2 Sound Levels

Historically, the magnitudes of sonic booms have been expressed largely in terms of peak overpressures, Δp, or in terms of the time integral of overpressure during the positive phase of the boom, called the positive impulse, I_o. These quantities are generally used in assessing the effect of a boom on building structures.

One of the BOOM-MAP output options presents contours of constant overpressure in pounds per square foot (psf) in accordance with equation (9).

For assessing the effects of sonic booms on people, various sound levels in decibels are more useful [A6]. Of the three such measures that have been used*, BOOM-MAP calculates contours in terms of the C-weighted sound-exposure level. The C-weighted sound exposure level, abbreviated as CSEL, symbolized as L_{CE}, is recommended in Reference A6 and used by various Department of Defense agencies for describing the effect of individual sonic booms on human response. C-weighted sound exposure level is the time integral over the duration of the boom of C-weighted, squared sound pressure, expressed in decibels. C-weighting is a standarized frequency weighting specified for sound level meters [A7].

The CSEL is calculated as:

$$L_{CE} = 10 \log_{10} (\Delta p)^2 + 101.6 \qquad (14)$$

The above expression is based upon experimental findings that for sonic booms from fighter aircraft operating in the Mach number and altitude ranges of interest for air combat maneuvering, the C-weighted sound exposure level is approximately 26 dB lower than the peak flat sound pressure level, L_{pk} (A8). Thus:

$$L_{CE} = L_{pk} - 26 \qquad (15)$$

*The three measures are: peak flat sound pressure, C-weighted sound exposure level, and A-weighted sound exposure level.

2.3 Sound Levels at Lateral Cutoff

At or near the nominal lateral cutoff distance, experimental measurements indicate rather sharp decreases in sonic boom overpressure with the sonic boom disintegrating into a ragged sine wave shape. To depict the variation in CSEL as a function of distance in the vicinity of the cutoff point, a general curve was assumed which is illustrated in Figure A-3. For distances equal to or less than 0.8 d_C, the CSEL values are assumed to decrease at a rate of 15 dB per decade increase in distance. From 0.8 to 1.0 d_C, a sharper decrease in levels is assumed which results in an approximate 10 dB decrease in CSEL at the cutoff distance. For larger distances, the levels are assumed to fall off at a rate of 25 dB per decade decrease. This procedure allows rapid truncation of the sonic boom levels in the vicinity of the cutoff level but avoids major discontinuities in the noise level versus distance curves [A9].

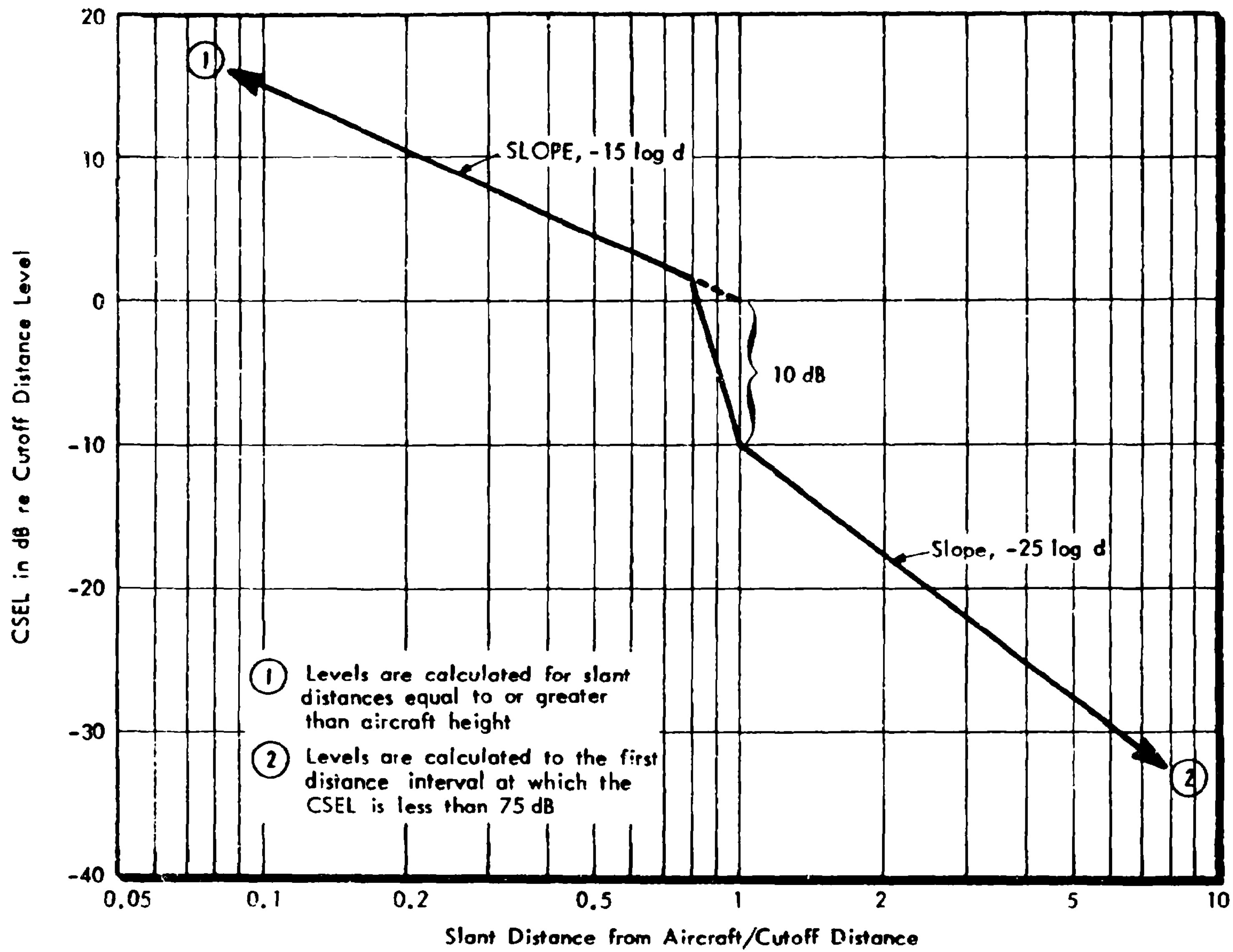


FIGURE A-3 ASSUMED VARIATION OF SONIC BOOM CSEL VALUES WITH SLANT DISTANCE

3.0 GEOMETRICAL AND COMPUTATIONAL ALGORITHMS

The equations given above predict boom exposure at a specific instant in time given a number of flight parameters. BOOM-MAP operates on a dynamic basis--using a series of snapshots of aircraft parameters at closely spaced (approximately 1.5 seconds) intervals in time. This section describes the methods for evaluating boom strengths at these instantaneous points in time and for interpolating between them to predict ground exposure at specific grid points.

3.1 The Grid

BOOM-MAP projects flight tracks and estimated boom strengths onto a flat ground plane. The altitude of this ground plane above mean sea level is MOA range elevation at its center (x = 0, y = 0 range coordinates). To generate noise contours the program evaluates boom strengths at specific x, y ground locations and uses the GPCP II contouring program to contour the boom strength "Terrain" based on a rectangular grid of ground locations. The program uses 102 equally spaced points in the x and y directions, with 2500 foot spacing between them. The range (in feet) covered by this grid is -126250 to +126250, or plus or minus 23.9 statute miles.

3.2 Library Data Interpolation

The time sequence of flight data is stored in the TACTS/ACMI library at approximate 1.5 second intervals. The exact interval is variable due to a number of conditions discussed in Section 2. In order to progress computationally through the library data in an orderly fashion flight parameters are interpolated from the library data at 1.0 second intervals. Land areas on the ground where propagating booms are received are evaluated by using pairs of data points at these one second intervals.

3.3 Boom Exposure Area Geometry

Figure A-4 shows a plan view of the ground plane area affected during a one second elapsed time interval. The boom wavefront propagates forward from the aircraft. BOOM-MAP computes the affected area by calculating the forward propagation distance (d_x) and the lateral cutoff distance, $d_{y,c}$, at the two instants in time. Two four-sided polygons are then constructed based on the forward and lateral projections (lateral calculations are carried out to $2d_{y,c}$ to ensure a smooth roll-off of boom strength down to values lower than anticipated contour values). Grid points lying within the polygons are then evaluated for estimated boom strength.

3.4 Grid Point Boom Exposure Evaluation

Grid point boom exposure at a grid point contained by the the polygon is performed by lateral and longitudinal interpolation. Figure A-5 illustrates the procedure. First, a line is drawn through the grid point which connects points (A and B) on the two laterals of equal fractional cutoff distance. The boom overpressure is computed at these two points based on the two flight parameter snapshots one second apart. The boom strength at the grid point is obtained by a simple distance interpolation along the connecting line between A and B.

3.5 Special Considerations

Under some circumstances the turn radius of the aircraft is less than twice the lateral cutoff distance. When this occurs the geometry of Figure A-2 changes, as illustrated in Figure A-6. The crossover of lateral propagation lines creates no computational problems geometrically. It does, however, create a condition under which a single grid point on the inside of the turn may be visited on several consecutive occasions, as the aircraft position is evaluated at one second intervals.

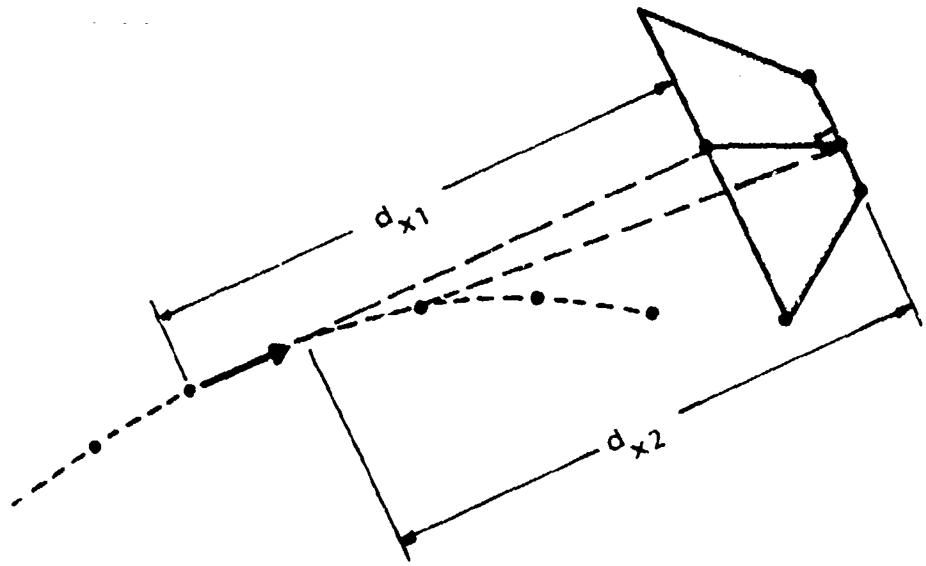
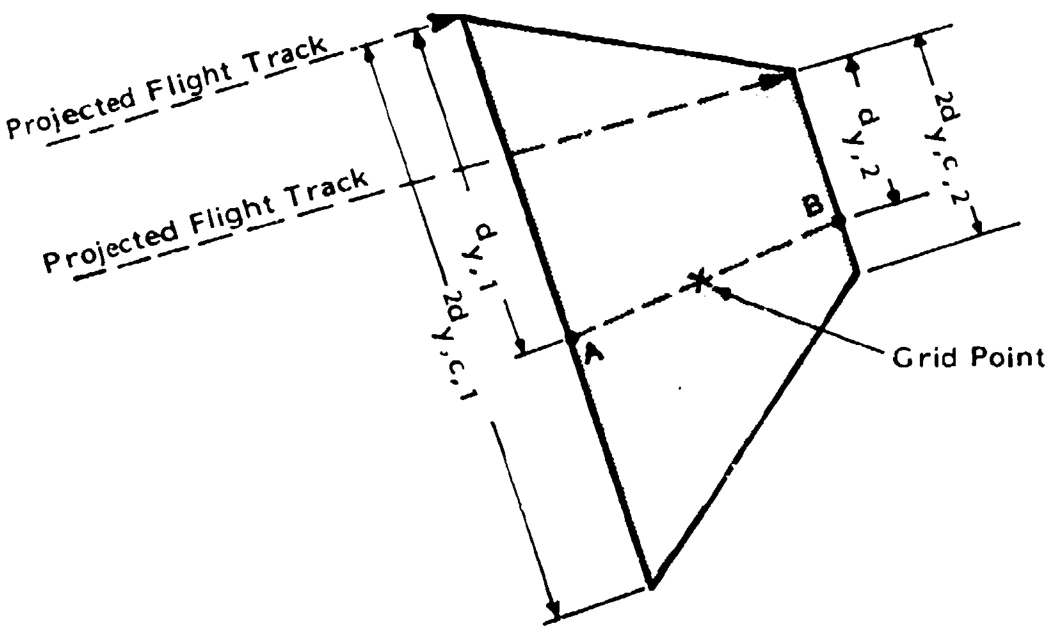


FIGURE A-4. AFFECTED BOOM AREA FROM FLIGHT TRACK SEGMENT



$$\alpha = \frac{d_{y,1}}{2d_{y,c,1}} = \frac{d_{y,2}}{2d_{y,c,2}}$$

FIGURE A-5. INTERPOLATION PROCEDURE TO ESTABLISH GRID POINT EXPOSURE

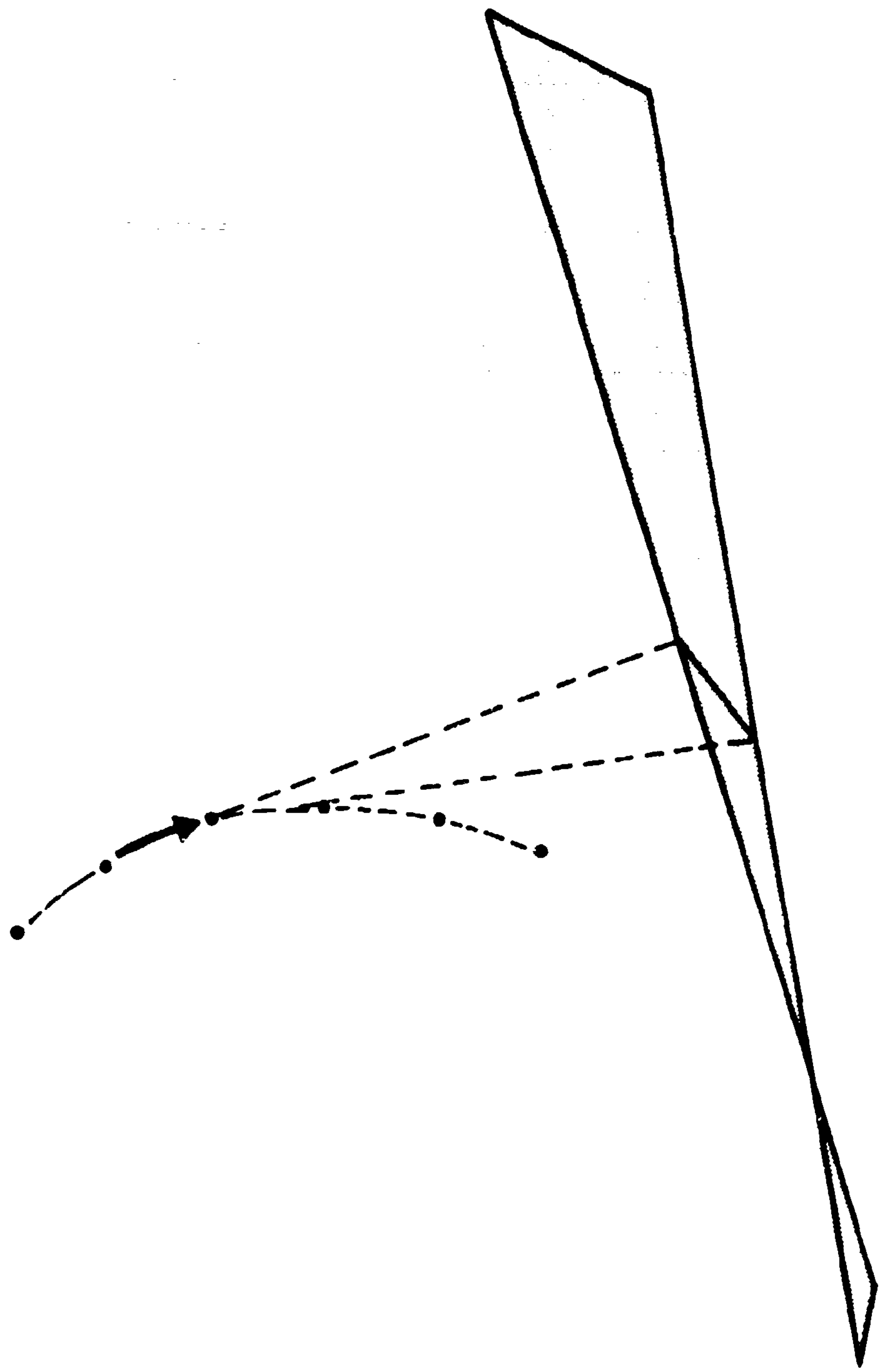


FIGURE A-6. AFFECTED BOOM AREA FROM LATERAL PROPAGATION DISTANCE GREATER THAN AIRCRAFT TURN RADIUS

Three options for handling this situation present themselves: (1) use the exposure computed on the first visit and ignore all subsequent visits, (2) energy sum the exposure from all visits, or (3) retain only the maximum value from all visits. The first option is risky in that the smoothness of the overpressure terrain may be dependent on the order in which adjacent grid points are visited as the aircraft progresses through the turn. The second option is equally risky in that multiple visits to a few adjacent points could create a locally high exposure area. Since the mathematical model does not provide for focussing effects, there is no reason to believe that this energy summation would realistically estimate the exposure in a potential focus area.

The third option, the max-picker, is probably the most viable, with some qualifications. The qualifications are designed to correctly account for two separate and distinct passbys by a single aircraft sortie. The implementation of the max-picker works as follows. Each time a grid point is visited, the time-of-day associated with the visit is updated in an array parallel to the flight grid array. If the elapsed time from the last visit is less than or equal to five seconds, the flight exposure grid point is updated with the maximum of the existing value and the new value. If the elapsed time is greater than five seconds, the existing grid exposure is energy summed into the master accumulation grid, the new exposure is replaced in the flight grid and the time-of-day is replaced in the time grid.

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A4. Galloway, W. J., "Studies to Improve Environmental Assessments of Sonic Booms Produced During Air Combat Maneuvering," AFAMRL-TR-83-078, August 1983.

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A8. Schomer, P. D., "Growth Functions for Human Response to Large-Amplitude Impulse Noise," Journal of the Acoustical Society of America, 64, pp. 1627-1632, 1978.

A9. Bishop, D. E., "Procedures and Data for Predicting Day-Night Levels for Supersonic Flight and Air-to-Ground Gunnery," BBN Report 3715, December 1978.

APPENDIX B

SELECTED INFORMATION
from
DATA REDUCTION USER GUIDE
FOR
MISSION STANDARD
DATA REDUCTION PROGRAMS

DECEMBER 16, 1981

PREPARED FOR TACTS/ACMI
AT CUBIC CORPORATION
SAN DIEGO, CALIFORNIA

BY

MIKE ST CLAIR
ABBAS ROSTAMIZADEH

SECTION I

MISSION STANDARD CCS RECORDING TAPE

A. TAPE LAYOUT

The recording contains all fundamental measurement qualities for the mission and is done on a 9 track tape at a density of 1600 bytes per inch (IBM compatible). It begins with a tape label record which is followed by a static data record and repeating dynamic data records which continue until one of the following conditions occur:

1. A Watchdog Data Record is reached followed by an End of File mark. This signifies an end of mission.
2. A Watchdog Data Record is reached followed by a new Static Data Record and repeating Dynamic Data Records. This signifies a pod swap or a change in exercise data.
3. The End of Tape Mark is reached signifying the end of a reel but not the end of a mission.

The last record on a mission recording tape is a Watchdog Data Record. The following illustrations show the layout of a Mission Standard CCS recording tape.

SINGLE REEL	MULTIPLE REEL	
TAPE LABEL RECORD	TAPE LABEL RECORD	TAPE LABEL RECORD
STATIC DATA RECORD	STATIC DATA RECORD	STATIC DATA RECORD
DYNAMIC DATA RECORD	DYNAMIC DATA RECORD	DYNAMIC DATA RECORD
DYNAMIC DATA RECORD	DYNAMIC DATA RECORD	DYNAMIC DATA RECORD
. .	. .	. .
WATCHDOG DATA RECORD	WATCHDOG DATA RECORD	WATCHDOG DATA RECORD
STATIC DATA RECORD	STATIC DATA RECORD	STATIC DATA RECORD
DYNAMIC DATA RECORD	DYNAMIC DATA RECORD	DYNAMIC DATA RECORD
. .	. .	. .
DYNAMIC DATA RECORD		DYNAMIC DATA RECORD
WATCHDOG DATA RECORD		WATCHDOG DATA RECORD
EOF		EOF
EOF	EOT	EOF

Note: Single reel tapes may be placed on any magnetic tape drive, but multiple reel tapes must start on drive 1, then drive 2, etc.

TAPE FORMAT

B. TAPE LABEL (HEADER) RECORD

This record consists of eight words (32 bytes), the first of which is the record type with an integer one identifying it as the tape label record.

	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
0	Record Type 1	
1-2	Date of Exercise	
3-6	Exercise Name	
7	Reel Number	Site Location

Site Locations are:	1 =	Nellis	Unmanned
	2 =	Yuma	Unmanned
	3 =	Oceana	Unmanned
	4 =	Sardinia	Manned
	5 =	Luke	Manned
	6 =	Tyndall	Not Updated
	7 =	Holloman	Manned
	8 =	Canada	Unmanned
	9 =	Korea	Manned
	10 =	Okinawa	Manned

Note: Unmanned/Manned refers to the architecture of the TIS which affects the Exercise Data Message, the Downlink Message, and the Uplink Message.

TAPE LABEL RECORD

C. STATIC DATA RECORD

The record consists of a maximum of 677 words (2708 bytes) organized into data blocks. The first word is the record type with an integer 2 identifying it as a static data record. Data Block selection will vary according to the site and type of mission being flown.

Data block organization is as follows:

Block Type Number	Name of Data Block
201	ACM Modes 1-5 Exercise Data Message
202	ACM Mode 6 Exercise Data Message
203	Shrike and No Drop Bombing Exercise Data Message
204-205	Reserved for Expansion
206	Sun and Atmosphere
207	Remote Site Positions
208	Pod Orientation
209	Range Status
210	Pod and Calibration Phase Delays
211	Calibration Bypass Cable Delay
212	Site Location Message

ACM MODE 1-5 EXERCISE DATA MESSAGE

Bits: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Word	Fields
0	Block Type 201 | Block Length 200
1	Hour | Minute | Second | 1/100 Second
2	A | Msg Label | Range Time
3	Cumulative DDSC Status | ET | EC
4-5	Date of Exercise
6 . 9	Exercise Name
10 . 16	RTO Name and Squadron
17	Ex. Mode | CDT | CDL | CDE
18	Vertical Parity Word
19	CD | A/C Type
20	Pod ID

Word	Bits (left half)	Bits (right half)
21	Pod	ID
22–23	A/C Tail	Number
24–25	Pilot	Squadron
26 . 29	Pilot	Name
30 . 33	RIO	Name
34	IAS	Limit
35		Altitude Limit
36	Angle of Attack Limit	
37	G	Limit
38	Weapon	Types
39	Vertical Parity Word	
40 . 186	Repeat words 19 to 39 for 2nd to 8th high-activity A/C	
187	Pod ID - 1st Low-Activity	A/C
188 . 198	Repeat word 187 for 2nd to 12th low-activity A/C	
199	Vertical Parity Word	

<u>ACM MODES 1-5 EXERCISE DATA MESSAGE DATA BLOCK 201</u>

ACM MODE 6 EXERCISE DATA MESSAGE

Bits: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Word	Fields			
0	Block Type 202		Block Length 199	
1	Hour	Minute	Second	1/100 Second
2	A	Msg Label	Range Time	
3	DDSC Status	L	ACM NO.	Mode

Word						
4 5	Date of			Exercise		
6 . 9	Exercise			Name		
10 . 16	RTO Name and			Squadron		
17	Ex. Mode			CDT	CDL	
18	Vertical Parity Word					
19	CD	Cnt1	Wpt1	Cnt2	Wpt2	A/C Type
20	Pod			ID		
21	A/C Tail			Number		
22 23	Pilot or Call			Squadron Sign		
24 25 26	Pilot			Name		
27	Vertical Parity Word					
28 . 198	Repeat Words 19 to 27 for 2nd thru 20th A/C					

ACM MODE 6 EXERCISE DATA MESSAGE DATA BLOCK 202

SHRIKE AND NO DROP BOMBING EXERCISE DATA MESSAGE

Bits: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Word				
0	Block Type 203		Block Length 101	
1	Hour	Minute	Second	1/100 Second
2	A Msg Label	Range Time		
3				
4 5	Date of		Exercise	
6 .	Exercise		Name	

Word						
9						
10 . 16	RTO Name		and Squadron			
17	Shrike Mode	Pk		CDT	CDL	CDTGT
18	Vertical Parity Word					
19				CD	WPT	A/C Type
20	Pod		ID			
21 22	A/C Tail		Number			
23 24	Pilot or Call		Squadron Sign			
25 . 28	Pilot		Name			
29	IAS Limit					
30			Altitude Limit			
31	AOA Limit					
32	G		Limit			
33	Vertical Parity Word					
34 . 138	Repeat Words 19-33 for A/C 2-8					
139	Tgt Type		Target Position Z Coordinate			
140	Target Elevation		Target Position Y Coordinate			
141	Target Azimuth		Target Position X Coordinate			
142 . 159	Repeat Words 139 - 141 for Targets 2 thru 7					
160	Vertical Parity Word					

SHRIKE AND NO DROP BOMBING EXERCISE DATA MESSAGE DATA BLOCK

D. DYNAMIC DATA RECORD

This record consists of 3000 words (12000 bytes). The first word is always an integer 3 and is followed by a variable series of data blocks which may be grouped in any sequence within a specific time period.

The key to this record is that each data block's first word contains the block type number and block length and the second word has the time in hour, minute, second, and one hundredth second format. This allows a program pointer to read the first two words of a data block and determine if that data block is to be used in the program. The block index is as follows:

Block Type Number	Name of Data Block
301	Manned Downlink
302	Unmanned Downlink
303	Manned Uplink
304	Unmanned Uplink
305	Filter Output
306	Weapon Fire
307	Maneuver Data Message Mode 1 to 5
308	Maneuver Data Message Mode 6
309	Manual Fire Status Change
310	Remote Site Positions
311	Simulation I/O
312	Shrike Maneuver Data Message
313	No Drop Bombing Maneuver Data Message

System Timing

When the number of high activity aircraft are four or less (uni-cycle), the system works on a 100 millisecond cycle. Downlink and its resultant uplink are sent and received within the same 100 millisecond time frame.

When the number of high activity aircraft are five or more (bi-cycle), the system works with two 100 millisecond cycles. Downlink is sent in one 100 millisecond time frame and its resultant uplink is sent back in the next 100 millisecond time frame.

The Unmanned Systems will display data in the DDS 100 milliseconds after the same data is recorded on the CCS Mission recording tape. This disparity is caused by the transfer time from the CCS to the DDS. The Manned Systems will display data in the DDS with the same recorded time as the CCS. When comparing a printout of DDS engineering data to a data reduction printout this should be taken into consideration.

FILTER OUTPUT

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

0	305		49		
1	Hour	Minute	Second	1/100 Second	
2	Slot (1-20)		Pod ID		
3-5	Range Positions X,Y,Z				
6-8	Velocity X,Y,Z				
9-11	Acceleration Components X,Y,Z				
12-14	Angular Rate Components P,Q,R				
15	Orientation Roll				
16	Orientation Pitch				
17	Orientation Heading				
18	Indicated Air Speed				
19	True Air Speed				
20	Mach				
21	Angle of Attack				
22	Angle of Sideslip				
23	Normal Acceleration				
24-32	Direction Cosine Matrix				
33	U-Bit	P-Bit	Int		Itrack
34-36	Weapon Seeker Unit Vector				
37	Random Number				
38	Spare	6 Sense Switches			
39	Angle of Attack Inertial				
40	Angle of Sideslip Inertial				
41-47	Corrected Loop Ranges 1-7				
48	Barometric Height of A/C				

FILTER OUTPUT DATA BLOCK 305

FILTER OUTPUT

Word	Bits 0–31			
0	305		49	
1	Hour	Minute	Second	1/100 Second
2	Slot (1-20)		Pod ID	
3-5	Range Positions X,Y,Z			
6-8	Velocity X,Y,Z			
9-11	Acceleration Components X,Y,Z			
12-14	Angular Rate Components P,Q,R			
15	Orientation Roll			
16	Orientation Pitch			
17	Orientation Heading			
18	Indicated Air Speed			
19	True Air Speed			
20	Mach			
21	Angle of Attack			
22	Angle of Sideslip			
23	Normal Acceleration			
24-32	Direction Cosine Matrix			
33	U-Bit	P-Bit	Int	Itra[illegible]
34-36	Weapon Seeker Unit Vector			
37	Random Number			
38	Spare	6 Sense Switches		
39	Angle of Attack Inertial			
40	Angle of Sideslip Inertial			
41-47	Corrected Loop Ranges 1-7			
48	Barometric Height of A/C			

FILTER OUTPUT DATA BLOCK 305

E. WATCHDOG DATA RECORD

This record consists of 598 words (2392 bytes), the first of which is the record type with an integer four identifying it as a Watchdog Data Record.

WATCHDOG DATA RECORD

Bits: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

#	Bits 0–7	Bits 8–15	Bits 16–23	Bits 24–31
1	Record Type 4			
2	401		597	
3	Hour	Minute	Second	1/100 Second
4-11	On Range Count			
12-19	Default Positions Count			
20-27	Attitude Loss Count			
28-35	Attitude/Position Loss Count			
36-43	Length of Longest A/P Loss			
44-51	Number of A/P Losses > 30 Seconds			
52-115	Range Failures Count			
116-123	Zero Pressure Count			
124-131	Zero Range Count			
132-139	Zero AVQ Data Count			
140-203	Interrogator Use Count			
204-267	Area Use Count			
268-275	First Time on Range			
276-283	Last Time on Range			
283-523	Itrace Count			
524-531	P-Bit Count			
532-539	U-Bit Count			
540-547	Previous A/P Loss			
548-550	Exercise Date			
551-554	Exercise Name			

555-562	A/C Pod Identification Numbers
563-578	A/C Tail Numbers
579-594	Squadron Names
595-598	A/C Type Number (Site Dependent)

* The first record is numbered 1 and not 0 as in previous examples.

SELECTED DATA ITEM DEFINITIONS

Acceleration Components..........The acceleration of the aircraft as sensed by the pod. These are, in reality, the acceleration components of the pod which must be corrected for differences in pod orientation and alignment. Range: +/- 1976 feet per second squared. Format: Real. Derived from downlink messages (two's complement, fixed LSB = 0.060311 for P3 and 0.0625 for P4/P4S). Also derived from filter output with no scaling required.

A/C Tail Numbers..........The tail numbers of the aircraft coded in eight ASCII characters. Values: 0 through 9 = Blank each character. Format: ASCII.

A/C Type..........Aircraft Type and Pod Position keyed to a site dependent number from 1 to 64 as follows:

	NELLIS	YUMA	EAST COAST	LUKE & SARDINIA
1	F-4J/L	A-4/1	F-4J/L	F-4J/L
2	F-4J/R	A-4/2	F-4J/R	F-4J/R
3	F-4E/L	A-4/3	F-4E/L	F-4E/L
4	F-4E/R	A-4/4	F-4E/R	F-4E/R
5	F-111/L	A-4/5	F-111/L	F-111/L
6	F-111/R	A-6/1	F-111/R	F-111/R
7	F-14/L	A-6/5	F-14/L	F-14/L
8	F-14/R	A-7/1	F-14/R	F-14/R
9	F-5/L	A-7/2	F-5/L	F-5/L
10	F-5/R	A-7/4	F-5/R	F-5/R
11	F-8	A-7/5	F-8	F-8
12	F-8/L	A-7/7	F-8/L	F-8/L
13	F-8/R	A-7/8	F-8/R	F-8/R
14	A-7	AV-8/1	A-7	A-7
15	A-7/L	AV-8/5	A-7/L	A-7/L
16	A-7/R	F-4/20	A-7/R	A-7/R
17	A-7/LW	F-4/2I	A-7/LW	A-7/LW
18	A-7/RW	F-4E/8I	A-7/RW	A-7/RW
19	A-6/L	F-4E/80	A-6/L	A-6/L
20	A-6/R	F-5/1	A-6/R	A-6/R
21	F-15/LI	F-5/7	F-15/L	F-15/L
22	F-15/RO	F-14/1A	F-15/R	F-15/R
23	F-15/LO	F-14/1B	A-4/C	A-4/C
24	F-15/RI	F-14/8B	A-4/LI	A-4/LI
25	A-4/C	F-14/8A	A-4/RI	A-4/RI
26	A-4/LI	F-15/20	F-106/R	F-106/R
27	A-4/RI	F-15/2I	F-106/L	F-106/L
28	F-106/R	F-15/8I	F-16/L	F-16/L
29	F-106/L	F-15/80	F-16/R	F-16/R
30	F-16/L	F-16/1	F-104/LI	F-104/LI

31	F-16/R	F-16/9	F-104/RI	F-104/RI
32	F-104/L	F-14A/L	F-14A/L	F-18/L
33	F-104/R	F-14A/R	F-14A/R	F-18/R
34	F-5M/L	F-14B/L	F-14B/L	F-104/L
35	F-5M/R	F-14B/R	F-14B/R	F-104/R
36	F-15M/LI	F-14C/L	F-14C/L	A-10/L
37	F-15M/RO	F-14C/R	F-14C/R	A-10/R
38	F-15M/LO	F-4A/L	F-4A/L	F-15/LI
39	F-15M/RI	F-4A/R	F-4A/R	F-15/RI
40	F-16M/LI	F-4B/L	F-4B/L	F-4C/LO
41	F-16M/R	F-4B/R	F-4B/R	F-4C/RO
42	F-4M/L	F-4C/L	F-4C/L	F-4C/LI
43	F-4M/R	F-4C/R	F-4C/R	F-4C/RI
44	F-5T/L	F-4D/L	F-4D/L	
45	F-5T/R	F-4D/R	F-4D/R	
46	F-15T/LI	F-4F/L	F-4F/L	
47	F-15T/RO	F-4F/R	F-4F/R	
48	F-15T/LO	F-4G/L	F-4G/L	
49	F-15T/RI	F-4G/R	F-4G/R	
50	F-16T/L	F-14D/L	F-14D/L	
51	F-16T/R	F-14D/R	F-14D/R	
52	F-4T/L	F-18/1		
53	F-4T/R	F-18/20		
54		F-18/21		
55		F-18/8I		
56		F-18/80		
57		F-18/9		
58		OV-10/L		
59		OV-10/R		

60-64 RESERVED FOR FUTURE USE
Format: Integer.

Aircraft ID..........The number of the individual aircraft. Values: 0 = Null, 1 thru 8 = High-activity aircraft, 9 thru 20 - low activity aircraft. Format: Integer.

Block Length..........Length of a data block in the dynamic data record. Value: 0 to 3000 words. Format: Integer.

Block Type.........Delineates the block type as follows:

Block Type Number	Name of Data Block
Static Data Record	
201	ACM Modes 1-5 Exercise Data Message
202	ACM Mode 6 Exercise Data Message
203	Shrike and No Drop Bombing Exercise Data Message
204-205	Reserved for Expansion
206	Sun and Atmosphere
207	Remte Site Positions
208	Pod Orientation
209	Range Status
210	Pod and Calibration Delay Times
211	Calibration Bypass Cable Delay
212	Site Location Message
Dynamic Data Record	
301	Manned Downlink
302	Unmanned Downlink
303	Manned Uplink
304	Unmanned Uplink
305	Filter Output
306	Weapon Fire
307	Maneuver Data Message Mode 1 to 5
308	Maneuver Data Message Mode 6
309	Manual Fire Status Change
310	Remote Site Positions
311	Simulation I/O
312	Shrike Maneuver Data Message
313	No Drop Bombing Maneuver Data Message

Values: As shown above. Format: Integer.

Date of Exercise..........The date of the exercise. Values: Eight characters as follows: 1 = First digit of the month 0 to 9, 2 = Second Digit of the month 0 to 9, 3 = Slash, 4 = First digit of the day 0 to 9, 5 = Second digit of the day 0 to 9, 6 = Slash, 7 = First digit of the year 0 to 9, 8 = Second digit of the year 0 to 9. Format: ASCII

Exercise Name...........The name of the exercise entered by the RTO. Value: Up to 16 ASCII characters. Format: ASCII.

Filter Unreliable Bit (U)...........Indicates that the probable error associated with the update of parameters for a given aircraft by the inertial/DME integration filter has exceeded the allowable limit. 0 = Reliable, 1 = Unreliable. Format: Boolean.

Hour..........Hour of current range time. Range: 0-23, Format: Integer.

Mach..........Aircraft Mach number shall be provided for both the fighter and target aircraft. Range: 0 to 10. Units: Mach. Format: Real. Derived from Maneuver Data Message (multiply by .0078125). Also derived from Filter Output Data with no scaling required.

Mach Number (Mach or M)..........The ratio of the aircraft speed relative to the speed of sound in the surrounding air space. Range: 0 to 3-127/128 mach. Format: Real.

Minute..........Minute of current range time. Range: 0 to 59. Format: Integer.

Normal Acceleration..........Component of the aircraft acceleration vector along its Z axis (i.e., 1 g = 32.2 ft. per second squared). Range: +/- 10.0. Units: 1/16th g. Format: Real. Derived from Maneuver Data Message (signed magnitude, fixed format). Also derived from Filter Output and Sim Data with no scaling required.

P-Bit Count..........Number of cycles for which the TACTS/ACMI was predicting the position of the aircraft in the absence of credible data for continued filtering. Format: Integer.

Prediction Indicator (P)..........Indicates that the high activity aircraft is being updated based on predicted values. Vales: 0 = Not predicted, 1 = Predicted. Format: Boolean.

Range Position..........The range position of the aircraft or missile in X,Y, and Z coordinates. Range: X and Y are +/-131,071 feet. Z is from 0 to 65,535 feet. Format: Integer. Derived from Maneuver Date Message (Fixed Format) If Scl (Scale) = 1, multiply by 2.375. Also derived from Filter Output with no scaling requirement (real). (If escort A/C and scale = 0, multiply by 8. If scale = 1, multiply by 18.)

Record Type..........The first word in a record. Values: 0 = Null, 1 = Tape label record, 2 = Static data record, 3 = Dynamic data record, 4 = Watchdog data record. Format: Integer.

Reel Number..........The reel number for use in single or multiple reel operations. Range: Nonnegative. Format: Integer.

Second..........Second of current range time. Range: 0 to 59. Format: Integer.

1/100 Second..........1/100 Second of current range time. Range: 0 to 99. Format: Integer.

Site Location..........TACTS/ACMI site locations numbered as follows: 1 = Nellis Unmanned 2 = Yuma Unmanned 3 = Oceana Unmanned 4 = Sardinia Manned 5 = Luke Manned 6 = Tyndall Not Updated 7 = Holloman Manned 8 = Canada Unmanned 9 = Korea Manned 10 = Okinawa Manned.

Note: Unmanned/Manned refers to the architecture of the TIS which affects the Exercise Data Message, the Downlink Message, and the Update Message. Format: Integer.

Slot..........AIS pod slot number. Range 1 to 20. Format: Integer.

U-Bit..........See Filter unreliable bit.

Velocity..........The X,Y, and Z components of the aircraft velocity. Range: +/- 2047 feet per second. Format: Integer. Derived from Downlink (Two's complement, fixed format, LSB = 0.077198 for P3, LSB = 0.0625 for P4/P4S). Also derived from Filter Output (real) with no scaling required, from Maneuver Data (signed magnitude, fixed format), and from Simulation I/O (real) for fighter and target aircraft.

APPENDIX C

MOAOPS AND BOOM-MAP PROGRAM OUTPUT

MOAOPS Program EXTRCT Output

Using Input Data:

```
*SUPERSONIC DATA ONLY*
*DATA AT 1 SECOND INTERVALS
*OLD INDEX AND LIBRARY FILES TO BE USED
*FULL INDEX PRINTED*
*ANY = NUMBER OF FIRST TAPE REEL READ
/EOF
```

```
************************************
*    MISSION NAME: '205-5-UACT      *
*    MISSION DATE: 07/22/85         *
*  SITE LOCATION:  5 LUKE           *
*      REEL NUMBER:  2              *
************************************
```

MISSION SEGMENT	TYPE	STARTING TIME HR MIN SEC	FINISHING TIME HR MIN SEC	A/C NO	A/C TYPE	A/C TAIL NO	SEGMENT DURATION MIN SEC	% TIME SUPERSONIC

*** PARITY ERROR IN FILE 1 RECORD 2 ACCEPTED ***

MISSION SEGMENT	TYPE	STARTING TIME HR MIN SEC	FINISHING TIME HR MIN SEC	A/C NO	A/C TYPE	A/C TAIL NO	SEGMENT DURATION MIN SEC	% TIME SUPERSONIC
1	201	08:59 27.93	09:34 40.03	1	22 F-15	5049	35:12	3.43
				2	28 F-16	124	35:12	4.07
				3	28 F-16	116	35:12	9.17

NO OF RECORDS = 2166

*** END OF MISSION TAPE ***

LIBRARY TAPE LISTING

RECORD NO 3062 ONWARDS

5235-5-DACT 07/22/8506592793F-15 5045

SCORE 22 1 1 3SUP

09162705	.993	-67529.	30207.	12365.	-21.5	855.	352.	-304.	5.500
09162865	1.014	-65149.	30521.	11304.	-24.4	893.	50.	-405.	5.985
09163023	1.042	-64767.	30340.	11101.	-27.3	833.	-245.	-451.	5.395
09163185	1.073	-63586.	35730.	10372.	-27.9	700.	-504.	-450.	5.314
09163355	1.101	-62557.	34694.	9514.	-24.9	554.	-695.	-414.	3.572
09163515	1.101	-61726.	33490.	6977.	-19.3	495.	-815.	-335.	3.732
09164005	.996	-59447.	29064.	7730.	-16.6	470.	-941.	-201.	1.504
09164165	1.005	-58694.	27602.	7392.	-16.3	478.	-937.	-190.	1.323
09164325	1.007	-57935.	26058.	7093.	-9.7	465.	-934.	-160.	.971
09164485	1.011	-57175.	24560.	6709.	-9.9	458.	-925.	-163.	1.035
09164655	1.016	-56350.	22972.	6476.	-9.3	469.	-950.	-172.	1.382
09164815	1.023	-55611.	21462.	6257.	-7.6	479.	-932.	-144.	1.390
09164975	1.026	-54573.	19973.	6005.	-6.4	465.	-939.	-113.	1.447
09165135	1.030	-54140.	16474.	5932.	-5.0	456.	-941.	-91.	1.271
09165305	1.029	-53373.	16877.	5565.	-3.3	447.	-944.	-59.	1.196
09165465	1.032	-52676.	15253.	5975.	-1.1	434.	-940.	-20.	1.154
09165625	1.032	-51945.	13969.	5839.	.0	433.	-943.	0.	1.720
09165785	1.032	-51165.	12359.	5779.	-.4	455.	-941.	-7.	1.206
09165955	1.031	-50400.	10755.	5765.	.4	457.	-935.	7.	1.361
09170115	1.026	-49644.	9245.	5737.	.7	462.	-935.	13.	1.093
09170275	1.027	-48895.	7746.	5637.	-1.1	473.	-935.	-19.	1.046
09170435	1.024	-48122.	6315.	5543.	-2.0	455.	-912.	-35.	1.047
09170595	1.023	-47376.	4720.	5443.	-2.6	469.	-919.	-47.	.926
09170765	1.021	-46575.	3235.	5309.	-2.6	454.	-920.	-46.	.375
09170925	1.020	-45957.	1760.	5319.	-2.5	447.	-915.	-45.	.989
09171085	1.016	-45217.	333.	5275.	-1.9	450.	-905.	-34.	1.059
09171265	1.015	-44475.	-1257.	5267.	-1.6	441.	-916.	-23.	1.026
09171415	1.017	-43724.	-2724.	5179.	-1.7	455.	-915.	-30.	1.029
09171575	1.016	-42979.	-4173.	5122.	-1.6	409.	-904.	-25.	1.052
09171735	1.015	-42221.	-5619.	5072.	-1.9	471.	-905.	-33.	.947
09171905	1.014	-41425.	-7149.	5025.	-1.6	469.	-905.	-32.	.921
09172065	1.013	-40650.	-8577.	5204.	-1.3	469.	-895.	-23.	1.035
09172225	1.014	-39919.	-10000.	5004.	-.3	471.	-893.	-5.	1.245
09172395	1.011	-39159.	-11414.	5052.	1.7	487.	-877.	30.	2.095
09172555	1.005	-38272.	-12916.	5145.	3.9	549.	-835.	63.	1.355
09172715	.979	-37261.	-14222.	5261.	4.9	602.	-794.	65.	1.370
09172875	.991	-36315.	-15417.	5372.	4.3	654.	-743.	75.	.926

09344003 40 37

5235-5-DACT 07/22/8506592793F-16 124

SCORE 26 1 2 3SUP

09153235	1.004	-73477.	15772.	20259.	-16.9	-370.	872.	-207.	.955
09153495	1.020	-74060.	17175.	19801.	-16.7	-356.	867.	-267.	.990
09153655	1.031	-74544.	15709.	19342.	-16.4	-345.	900.	-264.	1.165
09153825	1.045	-75175.	20177.	16914.	-15.9	-331.	915.	-275.	.857
09153985	1.041	-75755.	21565.	16457.	-15.4	-326.	929.	-271.	1.041
09154145	1.080	-76246.	23115.	16047.	-14.1	-305.	956.	-252.	1.053
09154315	1.095	-76759.	24723.	17624.	-13.7	-277.	969.	-245.	1.270
09154475	1.101	-77196.	26340.	17302.	-12.9	-249.	990.	-233.	.975
09155125	.995	-75616.	32796.	15493.	-15.9	-168.	1006.	-292.	.506
09155285	1.013	-76919.	34429.	15026.	-16.0	-179.	1016.	-295.	1.111
09155445	1.031	-79257.	35742.	14552.	-15.7	-165.	1039.	-295.	.594
09155615	1.052	-79532.	37535.	14579.	-15.2	-160.	1050.	-269.	1.065

091557735	1.072	-79795.	39522.	13519.	-15.1	-150.	1056.	-205.	1.152
091559335	1.094	-80026.	41239.	13152.	-13.9	-134.	1076.	-223.	2.203
091600935	1.090	-80269.	42904.	12795.	-11.5	-147.	1060.	-214.	1.252
091602635	1.100	-80531.	44294.	12711.	-11.2	-140.	1062.	-211.	1.109
091604235	1.100	-81013.	45023.	12416.	-10.5	-116.	1090.	-204.	1.240
091623735	.993	-250335.	281993.	-10.	-.5	-168.	992.	-10.	.315
091625335	.990	-63253.	64195.	9233.	-.7	-169.	964.	-12.	.315
091626935	1.000	-53436.	70932.	6965.	-.9	-173.	977.	-15.	.315
091628635	1.005	-53605.	72741.	6855.	-4.4	-151.	1067.	-63.	.797
091630235	.994	-53799.	74446.	6711.	10.5	-475.	1027.	374.	5.410
093204633	1.004	-55176.	-1144.	19203.	-42.1	473.	567.	-684.	1.539
093206235	1.056	-54402.	-169.	16130.	-37.0	517.	648.	-626.	3.465
093207835	1.073	-53525.	914.	17165.	-29.6	579.	706.	-524.	3.617
093209435	1.073	-52543.	2901.	16433.	-23.7	633.	739.	-427.	2.637
093211135	.997	-51407.	3379.	15747.	-19.0	673.	705.	-363.	2.407
093212735	1.020	-50305.	4626.	15203.	-16.9	695.	761.	-313.	2.129
093214335	1.041	-49155.	5863.	14740.	-13.4	721.	759.	-254.	2.567
093215935	1.051	-47977.	7129.	14381.	-11.2	738.	764.	-213.	.520
093217633	1.059	-46719.	6451.	14009.	-11.0	748.	772.	-268.	2.639
093219233	1.040	-45433.	9509.	13765.	-6.7	869.	565.	-126.	6.044
093220835	1.030	-43916.	10263.	13574.	-7.1	994.	265.	-128.	6.583
093222435	1.026	-42305.	10531.	13353.	-7.6	1017.	56.	-136.	3.179
093224135	1.034	-40535.	10561.	13207.	-5.6	1036.	-9.	-162.	1.056
093225735	1.030	-39908.	10492.	13073.	-3.5	1024.	-92.	-65.	2.374
093227735	1.025	-37296.	10265.	12903.	-3.7	1006.	-141.	-65.	.756
09322905	1.022	-35657.	10965.	12567.	-3.4	1035.	-134.	-61.	1.277
093230635	1.025	-33967.	9764.	12794.	-2.4	952.	-239.	-43.	3.346
09323223	1.024	-32435.	9339.	12740.	-1.4	975.	-275.	-25.	1.550
093233835	1.030	-30554.	8957.	12675.	-3.5	992.	-215.	-63.	.195
093235435	1.026	-29239.	6534.	12535.	-6.0	967.	-195.	-105.	.564
093237135	1.022	-27519.	8307.	12375.	-2.4	975.	-195.	-42.	5.746
093238735	.996	-26107.	7379.	12531.	12.5	875.	-347.	203.	6.529

093440035 47 44

5253-5-DAUT 07/22/85059379SF-16 115

SLOAL 25 1 3 35UP

091534935	1.023	-47105.	19022.	21455.	-13.9	-204.	967.	-243.	.590
091536535	1.060	-47537.	20574.	21049.	-14.6	-267.	990.	-267.	.554
091538235	1.091	-48047.	22297.	20565.	-14.7	-273.	1015.	-275.	1.946
091539535	1.076	-46404.	23943.	20145.	-13.4	-277.	1045.	-253.	1.709
091541435	1.111	-46922.	25646.	19714.	-13.3	-276.	1072.	-261.	1.412
091543035	1.124	-49355.	27363.	19290.	-12.6	-279.	1099.	-253.	1.215
091544735	1.136	-49845.	29263.	18855.	-11.6	-279.	1129.	-238.	1.239
091546335	1.151	-50257.	31102.	18494.	-11.5	-279.	1151.	-237.	1.165
091547935	1.150	-50713.	32954.	18127.	-11.0	-267.	1173.	-234.	1.097
091549535	1.167	-51136.	34845.	17753.	-10.6	-265.	1195.	-225.	1.167
091551235	1.170	-51547.	36834.	17392.	-9.6	-327.	1200.	-215.	1.453
091552935	1.185	-52177.	38910.	17030.	-10.6	-340.	1210.	-240.	1.616
091554435	1.196	-52799.	40740.	16643.	-10.9	-404.	1207.	-245.	.047
091556035	1.205	-53449.	42676.	16222.	-12.7	-412.	1213.	-265.	-.401
091557735	1.235	-54115.	44757.	15731.	-13.5	-395.	1235.	-306.	1.212
091559335	1.277	-54740.	46770.	15255.	-12.4	-303.	1272.	-290.	1.340
091600935	1.254	-55291.	48635.	14763.	-11.2	-347.	1303.	-263.	1.900
091602635	1.291	-55841.	50921.	14417.	-7.6	-346.	1323.	-167.	1.946
091604235	1.296	-56423.	53160.	14101.	-7.6	-335.	1339.	-164.	1.212
091605835	1.303	-56950.	55342.	13525.	-6.2	-329.	1356.	-152.	1.530
091607435	1.311	-57404.	57510.	13529.	-7.0	-325.	1365.	-173.	.755
091609035	1.315	-58004.	59569.	13207.	-7.6	-365.	1359.	-165.	1.109
091610735	1.312	-58573.	61969.	12914.	-7.2	-449.	1341.	-178.	1.359
091612335	1.316	-59445.	64147.	12642.	-7.5	-473.	1344.	-167.	.930
091613935	1.324	-60162.	66307.	12377.	-6.6	-457.	1359.	-165.	1.765
091615535	1.315	-60593.	68450.	12173.	-5.2	-434.	1357.	-150.	1.259
091617235	1.295	-61520.	70759.	11977.	-5.1	-417.	1324.	-125.	1.175
091618835	1.290	-62273.	72551.	11776.	-5.5	-402.	1305.	-125.	.550

091820433	1.201	-62909.	74928.	11501.	-5.6	-391.	1202.	-131.	.625
091822093	1.153	-63519.	75951.	11352.	-4.4	-377.	1201.	-101.	2.109
091822733	1.169	-64192.	79065.	11154.	-3.2	-407.	1228.	-73.	1.860
091825333	1.155	-64867.	90997.	11032.	-1.3	-446.	1158.	-23.	3.547
091826933	1.144	-65611.	82953.	11073.	.6	-466.	1190.	17.	2.239
091828533	1.125	-66393.	94053.	11104.	.7	-497.	1109.	16.	.746
091830233	1.107	-67196.	86524.	11143.	.5	-479.	1091.	10.	1.625
091831933	1.086	-67977.	86251.	11246.	4.5	-499.	1056.	93.	3.059
091833433	1.058	-68816.	89594.	11439.	7.0	-543.	1000.	140.	3.340
091835033	1.026	-69704.	91394.	11726.	10.9	-630.	809.	211.	3.187
091744933	1.001	-56274.	54359.	25391.	-3.0	263.	-1054.	-57.	-.019
091748533	1.026	-55811.	52636.	25751.	-6.1	267.	-1068.	-117.	-.370
091748233	1.044	-55323.	50806.	25503.	-6.7	265.	-1076.	-170.	.196
091749833	1.056	-54305.	49702.	25205.	-9.7	265.	-1079.	-190.	.905
091751433	1.066	-54399.	47352.	24905.	-9.4	286.	-1063.	-165.	1.175
091753033	1.073	-53935.	45618.	24595.	-10.3	283.	-1053.	-204.	.312
091754733	1.082	-53446.	43766.	24243.	-11.0	300.	-1079.	-217.	.635
091756333	1.090	-52950.	42065.	23893.	-9.4	325.	-1079.	-167.	2.406
091757933	1.094	-52424.	40345.	23640.	-7.2	335.	-1079.	-143.	1.323
091759533	1.101	-51905.	38620.	23443.	-6.0	338.	-1077.	-113.	1.362
091801233	1.101	-51322.	36790.	23257.	-4.8	350.	-1072.	-95.	1.795
091802833	1.010	-50747.	35062.	23140.	-3.1	365.	-1065.	-61.	1.252
091804433	1.005	-50158.	33365.	23045.	-2.6	372.	-1056.	-56.	.586
091806033	1.004	-49559.	31701.	22909.	-1.9	391.	-1045.	-38.	1.330
091807733	.996	-48580.	29943.	22371.	-3.1	394.	-1037.	-61.	.372
091809333	.997	-48233.	28288.	22755.	-4.0	393.	-1032.	-73.	.944
091810933	.927	-47627.	26540.	22531.	-4.6	392.	-1026.	-63.	.627
091812533	.999	-47012.	24970.	22492.	-5.0	387.	-1031.	-95.	.546
091814233	1.002	-46353.	23232.	22336.	-5.2	381.	-1029.	-101.	.560
091815933	1.007	-45757.	21579.	22154.	-5.7	373.	-1031.	-109.	.652
091817433	1.013	-45161.	19937.	21977.	-6.3	362.	-1031.	-120.	1.012
091819033	1.021	-44592.	18282.	21771.	-6.6	344.	-1035.	-127.	1.190
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091822333	1.032	-43529.	14835.	21323.	-7.2	295.	-1047.	-133.	.596
091823933	1.035	-43050.	13152.	21119.	-5.4	272.	-1053.	-103.	1.071
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091830433	1.042	-41474.	6275.	20749.	-2.7	227.	-1059.	-51.	1.455
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091835333	1.039	-40316.	1101.	20642.	-.3	272.	-1047.	-5.	1.159
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091838533	1.038	-39407.	-2224.	20513.	-.7	297.	-1036.	-13.	.919
091840233	1.038	-38995.	-3950.	20604.	-.4	308.	-1032.	-9.	1.501
091841833	1.037	-38390.	-5651.	20595.	-.2	322.	-1026.	-4.	1.179
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091848333	1.024	-35564.	-12122.	20652.	2.3	506.	-944.	43.	1.167
091849933	1.021	-35070.	-13806.	20731.	2.0	519.	-928.	37.	1.013
091851533	1.017	-34240.	-15062.	20767.	1.5	524.	-921.	34.	.545
091853233	1.013	-33345.	-16538.	20947.	1.6	529.	-914.	27.	.445
091854833	1.011	-32492.	-18097.	20573.	.7	540.	-907.	12.	.920
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091858033	1.010	-30717.	-20992.	20927.	.0	562.	-897.	11.	1.305
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092003733	1.022	-36712.	-44134.	29323.	-23.2	940.	66.	-403.	.266
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092007033	1.095	-33549.	-43834.	27961.	-25.0	943.	93.	-443.	.723
092008733	1.100	-32197.	-43703.	27202.	-25.9	952.	101.	-457.	1.316
092010333	.991	-30535.	-43530.	26464.	-25.5	965.	105.	-465.	.691
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09201635	1.092	-24005.	-42553.	23334.	-25.0	1025.	115.	-461.	1.332
09201645	1.101	-22426.	-42530.	22592.	-23.3	1047.	122.	-453.	1.575
09202005	1.104	-20721.	-42429.	21900.	-21.0	1062.	170.	-413.	3.695
09202175	1.052	-18951.	-41968.	21239.	-16.5	1003.	373.	-355.	4.915
09202335	1.071	-17459.	-41153.	20755.	-13.2	849.	615.	-245.	7.019
09202495	1.026	-16262.	-39995.	20495.	-3.7	598.	806.	-65.	7.427
09344005	.102		.99						

INDEX FILE TO LIBRARY TAPE
FULL INDEX: 85/12/05.
SUPERSONIC DATA ONLY
13.14.16.

ENTRY NO	MISSION NAME	MISSION DATE	SITE NO	LOCATION	STARTING TIME HR M SEC	FINISHING TIME HR M SEC	A/C TYPE	A/C TAIL NO	STARTING RECORD NO	NO OF RECORDS	NO OF SUPERSONIC RECORDS
1	5196-18	07/15/85	5	LUKE	1526 5899	1530 4059	22 F-15	7163	2	4	1
2	5196-18	07/15/85	5	LUKE	1530 4069	1557 1441	22 F-15	7163	6	52	49
3	5196-18	07/15/85	5	LUKE	1526 5899	1530 4059	0	5049	58	3	0
4	5196-18	07/15/85	5	LUKE	1530 4069	1557 1441	22 F-15	5049	61	72	69
5	5196-1C	07/15/85	5	LUKE	1528 5899	1530 4059	15 A-7	406	133	3	0
6	5196-1C	07/15/85	5	LUKE	1530 4069	1557 1441	15 A-7	406	136	3	0
7	5196-1C	07/15/85	5	LUKE	1528 5899	1530 4059	15 A-7	210	139	3	0
8	5196-1E	07/15/85	5	LUKE	1530 4069	1557 1441	15 A-7	210	142	3	0
9	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	23 F-16	119	145	50	47
10	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	23 F-16	124	195	143	140
11	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	6555	338	169	166
12	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	519	507	139	136
13	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	432	646	181	178
14	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	677	827	91	88
15	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	22 F-15	5047	918	115	112
16	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	22 F-15	1063	1033	118	115
17	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	28 F-16	124	1151	106	103
18	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	28 F-16	118	1257	25	22
19	5282805-6PAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	067	1282	45	42
20	5282805-6PAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	135	1327	66	63
21	5282805-6PAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	115	1413	37	34
22	5282805-6PAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	116	1450	39	36
23	5284711-140A	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	21 F-15	096	1489	38	35
24	5284711-140A	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	39 F-4	132	1577	55	52
25	5284711-140A	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	38 F-4	146	1632	107	104
26	5284711-140A	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	21 F-15	100	1739	35	32
27	5282723-26KD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	22 F-15	133	1774	176	173
28	5282723-26KD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	22 F-15	148	1950	90	87
29	5282723-26KD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	21 F-15	112	2040	33	30
30	5282723-26KD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	21 F-15	100	2073	48	45
31	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	21 F-15	097	2121	3	0
32	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	21 F-15	099	2124	53	50
33	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	22 F-15	131	2177	168	165
34	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	22 F-15	119	2345	288	285
35	5282717-2001	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	22 F-15	131	2633	13	10
36	5282717-2001	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	21 F-15	101	2646	43	40
37	5282717-2001	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	21 F-15	134	2689	91	88
38	5282717-2001	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	22 F-15	121	2780	95	92
39	5203-5-DACT	07/22/85	5	LUKE	0859 2793	0934 4003	22 F-15	5049	3062	40	37
40	5203-5-DACT	07/22/85	5	LUKE	0859 2793	0934 4003	28 F-16	124	3122	47	44
41	5203-5-DACT	07/22/85	5	LUKE	0859 2793	0934 4003	28 F-16	118	3169	102	99

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*  MISSION INDEX FILE     *
*  UPDATED:  85/12/0_.    *
*             13.14.18.   *
* SUPERSONIC DATA ONLY    *
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MISSION NAME	MISSION DATE	SITE LOCATION
5196-18	07/15/85	LUKE
5203-15	07/22/85	LUKE
5197-5-DACT	07/16/85	LUKE
5262605-8PAL	10/09/85	HOLLUMAN
5264711-14DA	10/11/85	HOLLUMAN
5262723-26KO	10/09/85	HOLLUMAN
5260721-24	10/07/85	HOLLUMAN
5262717-20GI	10/09/85	HOLLUMAN
5203-5-DACT	07/22/85	LUKE

NUMBER OF MISSION TAPES ANALYZED = 9

END OF PROGRAM. LIBRARY AND INDEX UPDATED.

CHECK THAT THE FILES LIBRY,INDEX,MINDEX HAVE BEEN COPIED TO

MAGNETIC TAPE CORRECTLY (SEE DAYFILE)

MOAOPS Program DELETE Output

Using Input Data:

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'MISSION NAMES TO BE DELETED'
'ENTRY NUMBERS TO BE DELETED'
1
3
5
7
3[illegible]
40
42
43
45
4[illegible]
'END'
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ORIGINAL INDEX BEFORE DELETIONS. DATE 85/12/04. TIME 22.54.18.

0 47SUF 85/12/04. 22.54.18.

1	5196-18	07/15/85	5LUKE	152858991530405922F-15	7163	2	4	1
2	5196-18	07/15/85	5LUKE	153040691557144122F-15	7163	6	52	49
3	5196-18	07/15/85	5LUKE	1528589915304059 0	5049	58	3	0
4	5196-18	07/15/85	5LUKE	153040691557144122F-15	5049	61	72	69
5	5196-18	07/15/85	5LUKE	152858991530405915A-7	406	133	3	0
6	5196-18	07/15/85	5LUKE	153040691557144115A-7	406	136	3	0
7	5196-18	07/15/85	5LUKE	152858991530405915A-7	210	139	3	0
8	5196-18	07/15/85	5LUKE	153040691557144115A-7	210	142	3	0
9	5203-15	07/22/85	5LUKE	135644351428197128F-16	118	145	50	47
10	5203-15	07/22/85	5LUKE	135644351428197128F-16	124	195	143	140
11	5203-15	07/22/85	5LUKE	135644351428197140F-4	6555	338	169	166
12	5203-15	07/22/85	5LUKE	135644351428197140F-4	519	507	139	136
13	5203-15	07/22/85	5LUKE	135644351428197140F-4	432	646	181	178
14	5203-15	07/22/85	5LUKE	135644351428197140F-4	677	827	91	88
15	5197-5-DACT	07/16/85	5LUKE	085402470933195722F-15	5047	918	115	112
16	5197-5-DACT	07/16/85	5LUKE	085402470933195722F-15	1063	1033	118	115
17	5197-5-DACT	07/16/85	5LUKE	085402470933195728F-16	124	1151	106	103
18	5197-5-DACT	07/16/85	5LUKE	085402470933195728F-16	118	1257	25	22
19	5282805-8FAL	10/09/85	7HOLLOMAN	132418511358235122F-15	067	1282	45	42
20	5282805-8FAL	10/09/85	7HOLLOMAN	132418511358235122F-15	135	1327	86	83
21	5282805-8FAL	10/09/85	7HOLLOMAN	132418511358235122F-15	115	1413	37	34
22	5282805-8FAL	10/09/85	7HOLLOMAN	132418511358235122F-15	116	1450	39	36
23	5284711-14DA	10/11/85	7HOLLOMAN	114506271223387721F-15	096	1489	88	85
24	5284711-14DA	10/11/85	7HOLLOMAN	114506271223387739F-4	132	1577	55	52
25	5284711-14DA	10/11/85	7HOLLOMAN	114506271223387738F-4	146	1632	107	104
26	5284711-14DA	10/11/85	7HOLLOMAN	114506271223387721F-15	100	1739	35	32
27	5282723-26RO	10/09/85	7HOLLOMAN	153323731605462322F-15	133	1774	176	173
28	5282723-26RO	10/09/85	7HOLLOMAN	153323731605462322F-15	148	1950	90	87
29	5282723-26RO	10/09/85	7HOLLOMAN	153323731605462321F-15	112	2040	33	30
30	5282723-26RO	10/09/85	7HOLLOMAN	153323731605462321F-15	100	2073	48	45
31	5280721-24	10/07/85	7HOLLOMAN	154405291608082921F-15	097	2121	3	0
32	5280721-24	10/07/85	7HOLLOMAN	154405291608082921F 15	099	2124	53	50
33	5280721-24	10/07/85	7HOLLOMAN	154405291608082922F-15	131	2177	168	165
34	5280721-24	10/07/85	7HOLLOMAN	154405291608082922F-15	119	2345	288	285
35	5282717-20GI	10/09/85	7HOLLOMAN	124735111321451922F-15	131	2633	13	10
36	5282717-20GI	10/09/85	7HOLLOMAN	124735111321451921F-15	101	2646	43	40

37	5282717-20GI	10/09/85	7HOLLOMAN	12473511132145192 1F-15	134	2689	91	88
38	5282717-20GI	10/09/85	7HOLLOMAN	1247351113214519 22F-15	121	2780	95	92
39	5203-5-DACT	07/22/85	SLUKE	085927930827279322F-15	5049	2875	3	0
40	5203-5-DACT	07/22/85	SLUKE	082727930859279322F-15	5--)	2878	3	0
41	5203-5-DACT	07/22/85	SLUKE	085927930934400322F-15	5049	2881	40	37
42	5203-5-DACT	07/22/85	SLUKE	085927930827279328B-16	124	2921	3	0
43	5203-5-DACT	07/22/85	SLUKE	082727930859279328B-16	1	2924	3	0
44	5203-5-DACT	07/22/85	SLUKE	085927930934400328F-16	124	2927	47	44
45	5203-5-DACT	07/22/85	SLUKE	085927930827279328F-16	118	2974	3	0
46	5203-5-DACT	07/22/85	SLUKE	082727930859279328B-16	1	2977	3	0
47	5203-5-DACT	07/22/85	SLUKE	085927930934400328B-16	118	2980	102	99

INDEX ENTRIES DELETED FROM INDEX FILE, DATE 05/12/04. TIME 22.54.18.

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3	5196-18	07/15/85	SLUKE	1528589915304059 0	5049	58	3	0
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7	5196-18	07/15/85	SLUKE	152858991530405915A 7	210	139	3	0
39	5203-5-DACT	07/22/85	SLUKE	085927930827279322F-15	5049	2875	3	0
40	5203-5-DACT	07/22/85	SLUKE	082727930859279322F 15	5--)	2878	3	0
42	5203-5-DACT	07/22/85	SLUKE	085927930827279328F-16	124	2921	3	0
43	5203-5-DACT	07/22/85	SLUKE	082727930859279328F-16	1	2924	3	0
45	5203-5-DACT	07/22/85	SLUKE	085927930827279328F-16	118	2974	3	0
46	5203-5-DACT	07/22/85	SLUKE	082727930859279328F-16	1	2977	3	0

INDEX FILE TO LIBRARY TAPE
FULL INDEX: 86/01/20.
21.23.59.
SUPERSONIC DATA ONLY

ENTRY NO	MISSION NAME	MISSION DATE	SITE NO	LOCATION	STARTING TIME HR M SEC	FINISHING TIME HR M SEC	A/C TYPE	A/C TAIL NO	STARTING RECORD NO	NO OF RECORDS	NO OF SUPERSONIC RECORDS
1	5196-18	07/15/85	5	LUKE	1530 4069	1557 1441	22 F-15	7163	6	52	49
2	5196-18	07/15/85	5	LUKE	1530 4069	1557 1441	22 F-15	5049	61	72	69
3	5196-18	07/15/85	5	LUKE	1530 4069	1557 1441	15 A-7	406	136	3	0
4	5196-18	07/15/85	5	LUKE	1530 4069	1557 1441	15 A-7	210	142	3	0
5	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	28 F-16	118	145	50	47
6	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	28 F-16	124	195	143	140
7	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	655	338	169	166
8	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	519	507	139	136
9	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	432	646	181	178
10	5203-15	07/22/85	5	LUKE	1356 4435	1428 1971	40 F-4	577	827	91	88
11	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0937 1957	22 F-15	5047	918	115	112
12	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	22 F-15	1063	1033	118	115
13	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	28 F-16	124	1151	106	103
14	5197-5-DACT	07/16/85	5	LUKE	0854 0247	0933 1957	28 F-16	118	1257	25	22
15	5282805-8FAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	062	1282	45	42
16	5282605-8FAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	135	1327	86	83
17	5282805-8FAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	115	1413	37	34
18	5282805-8FAL	10/09/85	7	HOLLOMAN	1324 1851	1358 2351	22 F-15	116	1450	39	36
19	5284711-14DA	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	21 F-15	096	1489	88	85
20	5284711-14DA	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	39 F-4	132	1577	55	52
21	5284711-14DA	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	38 F-4	146	1632	107	104
22	5284711-14DA	10/11/85	7	HOLLOMAN	1145 0627	1223 3877	21 F-15	100	1739	35	32
23	5282723-26RD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	22 F-15	133	1774	176	173
24	5282723-26RD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	22 F-15	148	1950	90	87
25	5282723-26RD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	21 F-15	112	2040	33	30
26	5282723-26RD	10/09/85	7	HOLLOMAN	1533 2373	1605 4623	21 F-15	100	2073	48	45
27	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	21 F-15	097	2121	3	0
28	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	21 F-15	099	2124	53	50
29	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	22 F-15	131	2177	168	165
30	5280721-24	10/07/85	7	HOLLOMAN	1544 0529	1608 0829	22 F-15	119	2345	288	285
31	5282717-20GI	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	22 F-15	131	2633	13	10
32	5282717-20GI	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	21 F-15	101	2646	43	40
33	5282717-20GI	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	21 F-15	134	2689	91	88
34	5282717-20GI	10/09/85	7	HOLLOMAN	1247 3511	1321 4519	22 F-15	121	2780	95	92
35	5203-5-DACT	07/22/85	5	LUKE	0859 2793	0934 4003	22 F-15	5049	2881	40	37
36	5203-5-DACT	07/22/85	5	LUKE	0859 2793	0934 4003	28 F-16	124	2927	47	44
37	5203-5-DACT	07/22/85	5	LUKE	0859 2793	0934 4003	29 F-16	118	2980	103	[illegible]

```
**************************
*  MISSION INDEX FILE    *
*  UPDATED:  86/01/20.   *
*             21.23.59.  *
* SUPERSONIC DATA ONLY   *
**************************
```

MISSION NAME	MISSION DATE	SITE LOCATION
5196-18	07/15/85	LUKE
5203-15	07/22/85	LUKE
5197-5-DACT	07/16/85	LUKE
5282805-BFAL	10/09/85	HOLLOMAN
5284711-14DA	10/11/85	HOLLOMAN
5282723-26RD	10/09/85	HOLLOMAN
5280721 24	10/07/85	HOLLOMAN
5282717-20GI	10/09/85	HOLLOMAN
5203-5-DACT	07/22/85	LUKE

NUMBER OF MISSION TAPES ANALYZED   9

PLEASE CHECK THE ENTRIES DELETED.

IF THE DELETIONS ARE O.K. PURGE THE OLD INDEX FILES 'INDEX' AND 'MINDEX'
STORE THE NEW FILES 'INDEXN' AND 'MINDEXN' ON THE MAGNETIC TAPE WITH THE ASSOCIATED 'LIBRY' FILE.

PROGRAM ENDS

BOOM-MAP PROGRAM OUTPUT

```
SOURCE LISTING:

1:  TITLE  LUKE AFB MOA  ---  LIBRARY AS OF 23 JAN 1986
2:
3:  SITE  LUKE
4:  MISSION  5196-18, 5197-5-DACT, 5282805-8PAL, 5284711-14DA, 5282723-26RD,
             5280721-24, 5282717-20GI, 5203-5-DACT
5:
6:  TIME  ALL
7:  AIRCRAFT  ALL
8:
9:  WIDTH  11.
10: MACHTRK  360000
11: BOUMTRK  360000
12: STAT
```

TABLE: 1/ 1

SITE LOCATION	EXERCISE NAME	DATE (YYMMDD-YYMMDD)	TIME (HHMM-HHMM)	AIRCRAFT TYPE	TAIL NUMBER	#
LUKE	5196-18	ALL	ALL	ALL	ALL	1
	5197-5-DACT					2
	5282805-8PAL					3
	5284711-14DA					4
	5282723-26RD					5
	5280721-24					6
	5282717-20GI					7
	5203-5-DACT					8

TITLE: LUKE AFB MOA - - - LIBRARY AS OF 23 JAN 1986

NO	MISSION NAME	MISSION DATE	SITE LOCATION	STARTING TIME HR MN SECS	FINISHING TIME HR MN SECS	A/C TYPE	A/C TAIL NO	SUPERSONIC TIME (SEC)	BOOM TIME (SEC)
1	5196-18	07/15/85	LUKE	15:28:58.99	15:30:40.59	F-15	7163	.0	.0
2	5196-18	07/15/85	LUKE	15:30:40.69	15:57:14.41	F-15	7163	54.0	7.0
3	5196-18	07/15/85	LUKE	15:28:58.99	15:30:40.59		5049	.0	.0
4	5196-18	07/15/85	LUKE	15:30:40.69	15:57:14.41	F-15	5049	88.0	8.0
5	5196-18	07/15/85	LUKE	15:28:58.99	15:30:40.59	A-7	406	.0	.0
6	5196-18	07/15/85	LUKE	15:30:40.69	15:57:14.41	A-7	406	.0	.0
7	5196-18	07/15/85	LUKE	15:28:58.99	15:30:40.59	A-7	210	.0	.0
8	5196-18	07/15/85	LUKE	15:30:40.69	15:57:14.41	A-7	210	.0	.0
9	5197-5-DACT	07/16/85	LUKE	08:54:02.47	09:33:19.57	F-15	5047	148.0	6.0
10	5197-5-DACT	07/16/85	LUKE	08:54:02.47	09:33:19.57	F-15	1063	141.0	22.0
11	5197-5-DACT	07/16/85	LUKE	08:54:02.47	09:33:19.57	F-16	124	124.0	.0
12	5197-5-DACT	07/16/85	LUKE	08:54:02.47	09:33:19.57	F-16	118	20.0	.0
13	5203-5-DACT	07/22/85	LUKE	08:59:27.93	08:27:27.93	F-15	5049	.0	.0
14	5203-5-DACT	07/22/85	LUKE	08:27:27.93	08:59:27.93	F-15	5--)	.0	.0
15	5203-5-DACT	07/22/85	LUKE	08:59:27.93	09:34:40.03	F-15	5049	58.0	26.0
16	5203-5-DACT	07/22/85	LUKE	08:59:27.93	08:27:27.93	F-16	124	.0	.0
17	5203-5-DACT	07/22/85	LUKE	08:27:27.93	08:59:27.93	F-16	1	.0	.0
18	5203-5-DACT	07/22/85	LUKE	08:59:27.93	09:34:40.03	F-16	124	60.0	13.0
19	5203-5-DACT	07/22/85	LUKE	08:59:27.93	08:27:27.93	F-16	118	.0	.0
20	5203-5-DACT	07/22/85	LUKE	08:27:27.93	08:59:27.93	F-16	1	.0	.0
21	5203-5-DACT	07/22/85	LUKE	08:59:27.93	09:34:40.03	F-16	118	152.0	57.0
							TOTAL:	845.0	139.0

NUMBER OF SUPERSONIC SORTIES(FLIGHTS): 9
NUMBER OF BOOM PRODUCING SORTIES(FLIGHTS): 7

```
TITLE: LUKE AFB MOA - - - LIBRARY AS OF 23 JAN 1986

X-COORD                  LOWER BOUND CELL 2 = -132000.0    CELL SIZE = 5280.000
   0   0   0   0   0   0   0   0   0   7   7   7   0  21  16  24  30   2   0   0
   0   2   5   3   2   3   4   4   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0

Y-COORD                  LOWER BOUND CELL 2 = -132000.0    CELL SIZE = 5280.000
   0   0   0   0   0   0   0   0   0   2   4   1   0   0   0   2   6   4   5   7
   1   0   0   0   0   2   4  10   7   8   8   6  12  10   7   5   3   4   4   4
   4   5   4   0   0   0   0   0   0   0   0   0

Z-COORD                  LOWER BOUND CELL 2 =      750.0    CELL SIZE = 1000.000
   0   0   0   0   0   6  12   0   3   2   3  13  10   9   7   4  11   8   6   6
  10  13   5   4   0   1   0   0   0   3   3   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0

EFFECTIVE HEIGHT         LOWER BOUND CELL 2 =         .0    CELL SIZE = 1000.000    RMS =12840.672
   0   0   0   0   8  14   4   0   5   4   6  18  22  20   0   2   1   3   8   9
   4   1   4   2   0   2   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0

MACH NUMBER              LOWER BOUND CELL 2 =        1.0    CELL SIZE =      .020    RMS =     1.136
   0   0  18   3   9  36  17  12   8   6   5   2   2   0   3   6  10   2   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

 CF MACH NO.             LOWER BOUND CELL 2 =        1.0    CELL SIZE =      .020    RMS =     1.065
       0  23  41  34  34   1   6   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

EFFECTIVE MACH NO.       LOWER BOUND CELL 2 =        1.0    CELL SIZE =      .020    RMS =     1.254
   0   0  12   5   3   5  11  13  11   1   4   3   9   7   6   1   4   7   1   1
   4   2   1   5   4  12   1   2   2   2   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

OVERPRESSURE (PSF)       LOWER BOUND CELL 2 =         .0    CELL SIZE =      .250
   0   0   0   0   0   5   3   2  14  13   9  12   4   7  11   8   6  19   0   0
   0   0   0   0   0   0   0   0   0   0   0   1   1   2   6   3   1   3   2   2
   0   2   1   1   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0

PEAK LEVEL               LOWER BOUND CELL 2 =      115.0    CELL SIZE =      .500
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   5   1   0   2   0   1   1   4   9  10   3
   5   4   7   8   1   3  10   6   8   4  16   3   0   0   0   0   0   0   0   0
   0   1   4   8   4   4   3   2   0   0   0   0   0   0   0   0   0   0   0

C-LEVEL                  LOWER BOUND CELL 2 =       90.0    CELL SIZE =      .500
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   5   1   0   2   0   1   1   4   9  10   3   5   4
   7   8   1   3  10   6   8   4  18   3   0   0   0   0   0   0   0   0   0   1
   4   8   4   4   3   2   0   0   0   0   0   0   0   0   0   0   0   0   0

A-LEVEL                  LOWER BOUND CELL 2 =       60.0    CELL SIZE =      .500
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   5   1   0   0   0   2   0   0   1   1   4   2   7  10   2   2
   4   3   4   4   7   2   1   2   6   7   3   7   4   7  15   0   0   0   0   0
   0   0   0   0   0   0   0   0   1   2   5   5   4   3   3   1   2   0   0

TIME GREATER THAN MACH 1.0 (SEC) =   845    TIME GREATER THAN CUTOFF MACH NO (SEC) =   137
```

X-COORD LOWER BOUND CELL 2 = -132000.0 CELL SIZE = 5280.000

Y-COORD LOWER BOUND CELL 2 = -132000.0 CELL SIZE = 5280.000

52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	1	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	3	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	1	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

X-COORD LOWER BOUND CELL 2 = -132000.0 CELL SIZE = 5280.000

Y-COORD LOWER BOUND CELL 2 = -132000.0 CELL SIZE = 5280.000

52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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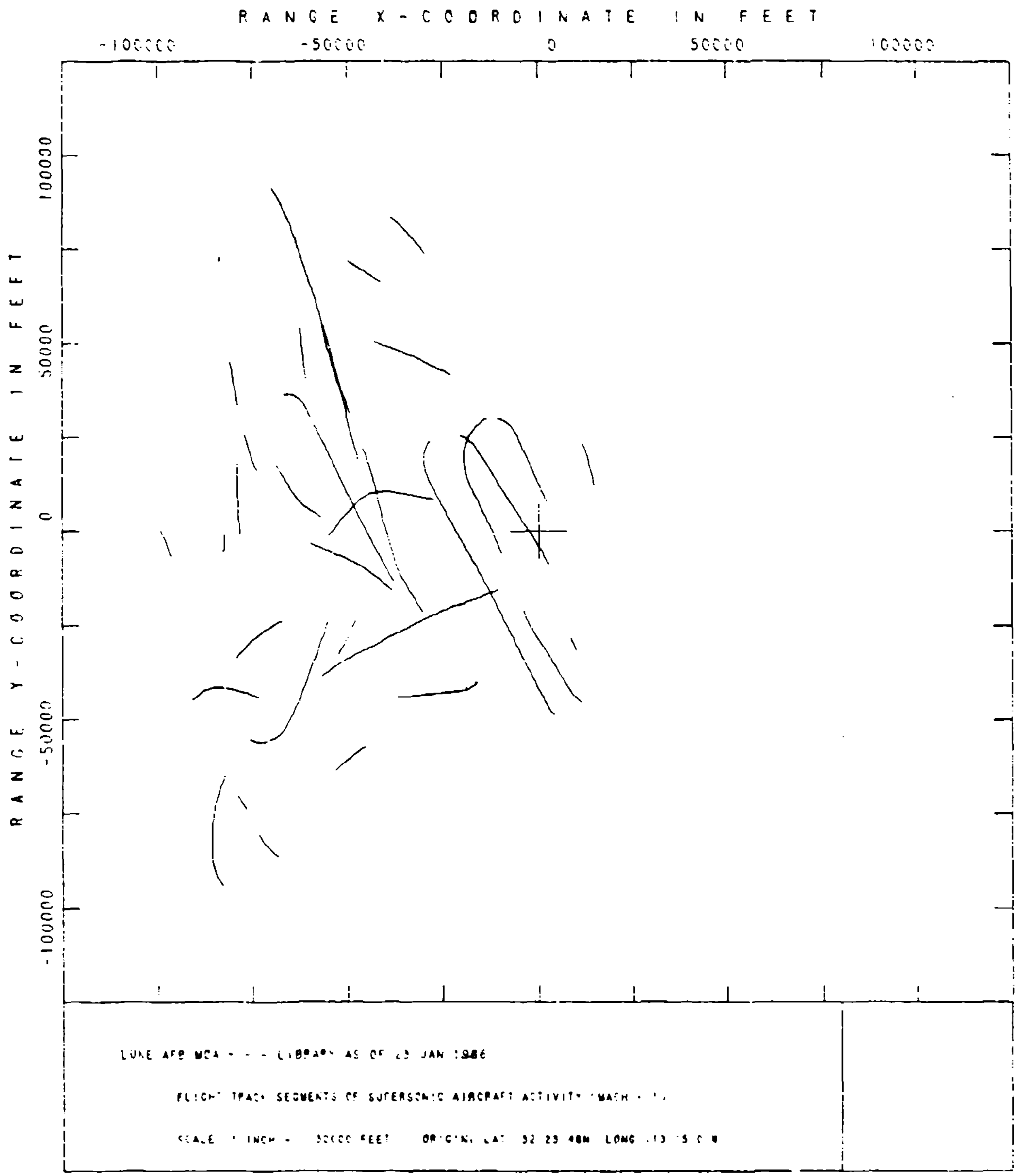
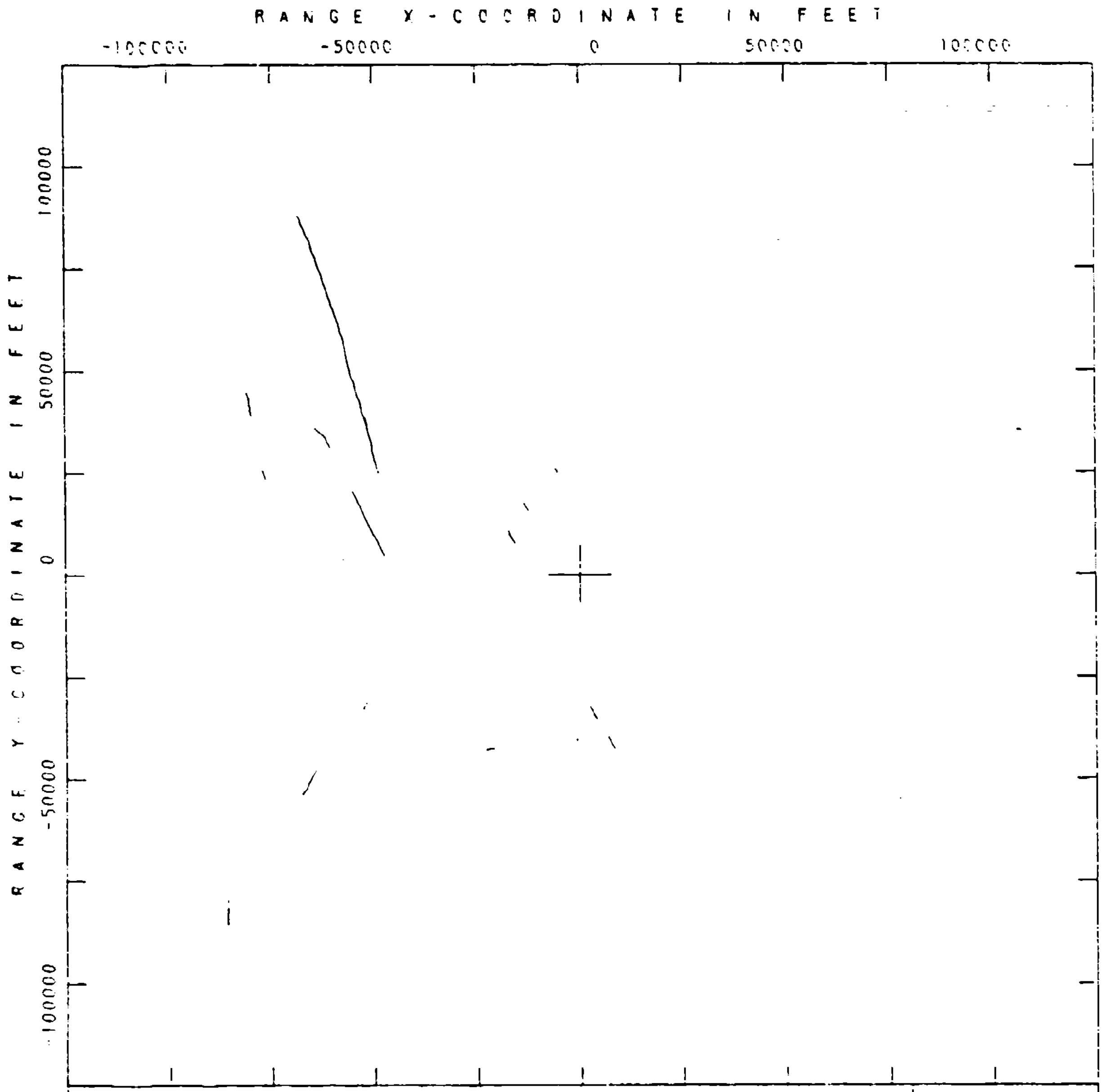
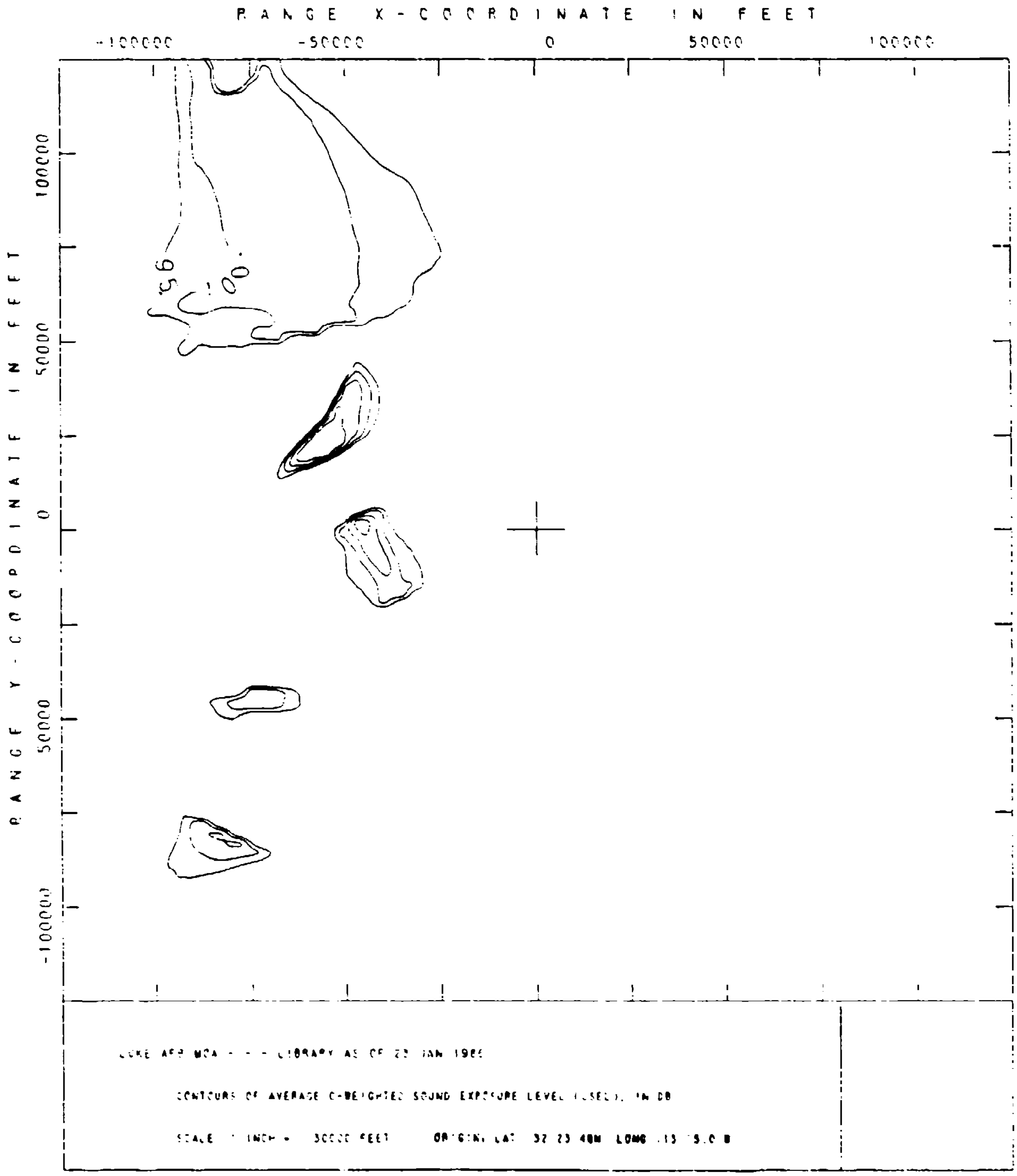

RANGE X-COORDINATE IN FEET
-100000
-50000
0
50000
100000
RANGE Y-COORDINATE IN FEET
100000
50000
0
-50000
-100000
LUKE AFB MOA
JAN 1986
FLIGHT TRACK SEGMENTS OF SUPERSONIC AIRCRAFT ACTIVITY (MACH
SCALE INCH FEET
LONG



LUKE AFB MOA - - - LIBRARY AS OF 23 JAN 1986

FLIGHT TRACK SEGMENTS OF SONIC BOOM PRODUCING AIRCRAFT ACTIVITY

SCALE 1 INCH = 30000 FEET ORIGIN: LAT 32 23.48N LONG 113 15.0 W


RANGE X-COORDINATE IN FEET
-100000
-50000
0
50000
100000
RANGE Y-COORDINATE IN FEET
100000
50000
0
-50000
-100000
95
100
LIBRARY AS OF 23 JAN 1985
CONTOURS OF AVERAGE C-WEIGHTED SOUND EXPOSURE LEVEL (CSEL), IN DB
SCALE 1 INCH = 30000 FEET
ORIGIN: LAT 32 23 40N LONG 113 15.0 W